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A COMBINED WATER-SUPPLY, IRRIGATION, AND POWER PROJECT.

By Burt A. Heinly.

It is our strong belief that it is not one of the functions of government, whether Federal, State, or municipal, to carry on engineering or commercial enterprises. The organization, the experience, the ideals necessary for efficient and economical conduct of such undertakings are best developed in worthy and responsible contracting and manufacturing concerns. The work described below appears to be an exceptional instance, owing its extraordinary success to an exceptional personality. To the man rather than the system, we believe, the admirable results achieved must be attributed, and they deserve publicity as a model and standard to be striven for elsewhere.—THE EDITORS.

EITHER necessity or gain forms the incentive for most great undertakings. In the instance of the 240 miles of aqueduct which the city of Los Angeles, California, now has under construction at a cost of $24,500,000, both entered into the conception of the scheme. First came the crying need for a larger domestic water supply. This need led to the discovery of the Owens River, 250 miles to the northward, in the heart of the Sierra Nevada mountains, as the source from which this necessity might be procured. The possibility of irrigation and of the development of electric power, with their promise of large commercial returns, have made the project possible financially.

It is almost an axiom of taxation that property owners are loath to levy tribute upon themselves, and large municipal public improvements come as a result of the vote of the non-taxpayer. Consider, then, that the city of Los Angeles has taxed itself $88 per capita by a vote of 21,918 to 2,128, and you have some idea of how much at heart and at stake the Angeleño has in the building of the Los Angeles aqueduct. Through this watercourse, to be completed by almost

Herculean labor within the next five years, it is proposed to deliver into the San Fernando Valley at the mouth of which Los Angeles is situated, 280,000,000 gallons of water every 24 hours. This is sufficient for a population of more than 1,000,000 people and the irrigation of 75,000 acres of land, contiguous to the city and now unproductive for lack of moisture. Forty miles from Los Angeles in the San Francisquito canyon there is a "step-down" in the proposed grade of the aqueduct of 1,500 feet, where it is planned to erect power houses at a cost of $6,500,000 for the development of electrical energy. This feature is not provided for in the expenditure of $24,500,000, but is to be taken care of by future bond issues.

WILLIAM MULHOLLAND.
Chief Engineer, Los Angeles Aqueduct.

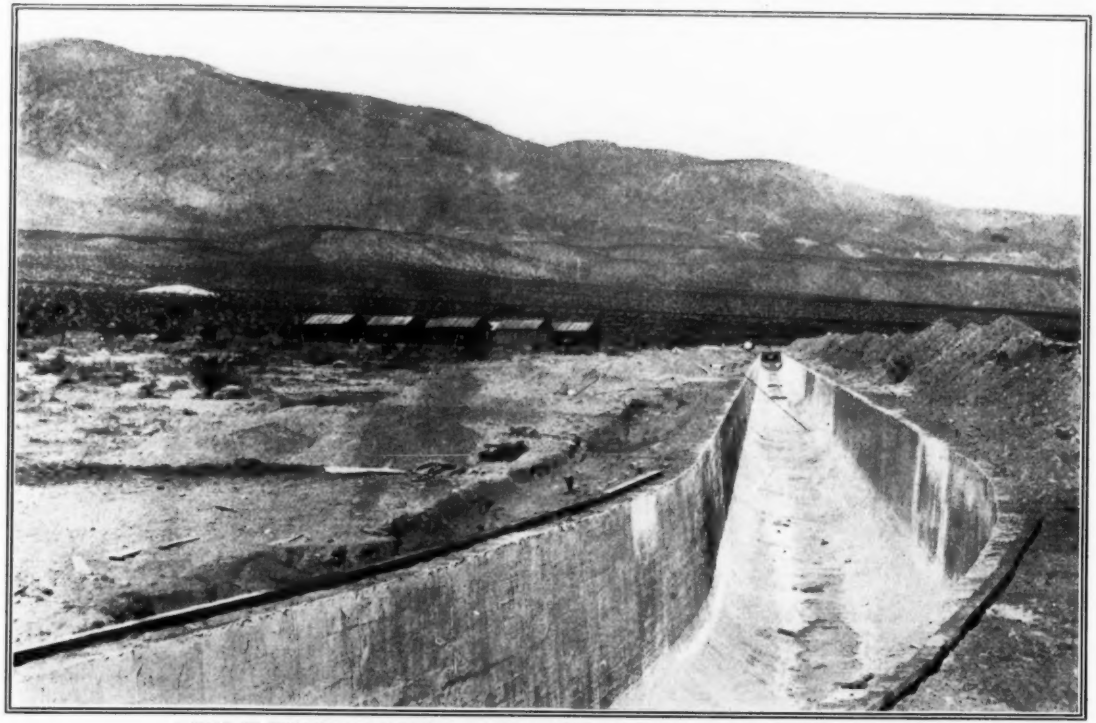
Five years ago scoffers looked upon the project as the phantasmal scheme of William Mulholland, water superintendent — a scheme made impossible by the tremendous difficulties to be overcome. Today three thousand men toiling in the heat of the Mojave Desert, the panting and puffing of a dozen steam shovels, and the clank and clug and whir of tunnel machinery, are evidences that the chimera of five years ago is at the present moment very much of an actuality.

The New York aqueduct, the greatest attempt at providing a water supply ever undertaken, is to be 122 miles long and is to cost $167,000,000 on completion. Construction is being undertaken where access to the work is comparatively easy, where the climatic conditions are not severe, and where the construction aid of railroads, telephones, telegraphs, steel mills, and cement factories, as well as very large labor markets, are close at hand. Compare these conditions with those encompassing the Los Angeles Aqueduct. This

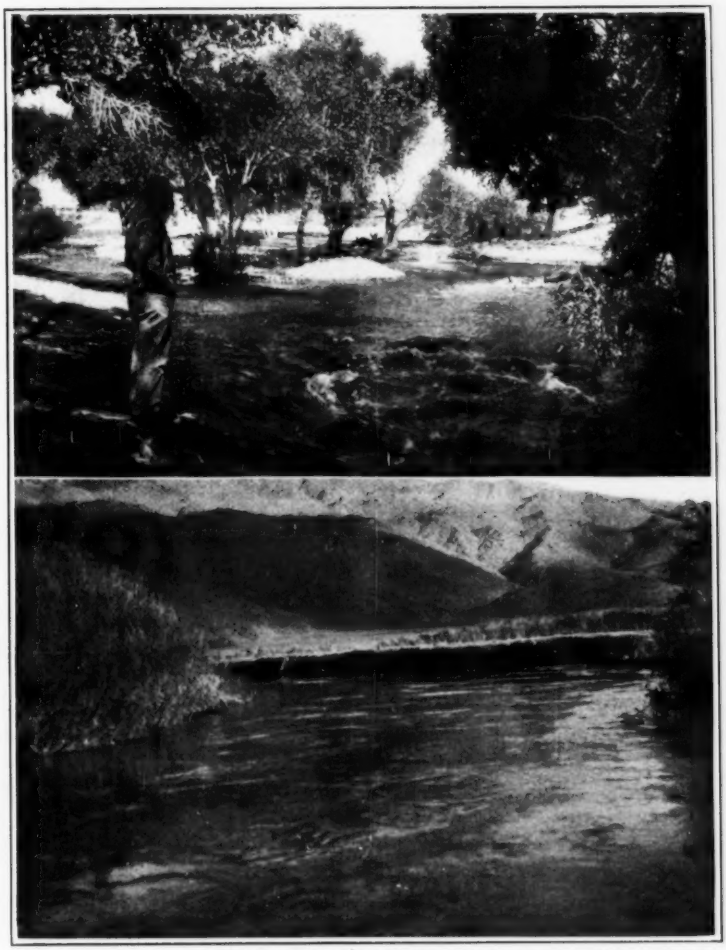
ON THE LINE BETWEEN THE OWENS VALLEY AND THE MOJAVE DESERT.
Alabama foothills in foreground. Sierra Nevadas in background.

watercourse is to be twice the length of the New York Aqueduct, and the route for almost the entire distance lies through an absolute desert which offers no food for man or beast and little, if any, water. For 60 miles the survey runs through a mountainous district, 300 to 1,200 feet above the floor of the desert, where Nature in her wildest mood has created a topsy-turvy land of rocky buttes, needle peaks, and canyons seared by volcanic fires and carved deeply by storms of sand and rain. For 5 miles the way leads beneath the Coast Range of mountains. Before the city's engineers began their work, the stage coach of the days of '49 and the saddle horse formed the only means of conveyance and communication. It is not strange, then, that the Los Angeles Water Board in inaugurating the enterprise prefaced one of their reports by stating that the "project is one of the boldest undertakings for providing a municipal water supply ever undertaken by a city."

The Owens River flows through a comparatively narrow valley in Inyo County, California, not far from the Nevada State line. This river takes its rise among the snow-clad peaks which form the outer rim of the Yosemite National Park, flows south for 100 miles to drain the eastern face of the Sierra Nevada Range, 2,800 square miles in area, and empties into Owens Lake, a saline body of water



A MILE OF COMPLETED AQUEDUCT IN THE MOJAVE DESERT, BEFORE THE COVER IS PUT ON.



BELOW, THE OWENS RIVER AT CHARLEY'S BUTTE—THE POINT OF INTAKE FOR THE LOS ANGELES AQUEDUCT. ABOVE, ONE OF THE STREAMS OF THE OWENS VALLEY.

covering 170 square miles with no outlet and lying within the northern edge of the Mojave Desert. The city, to procure possession of the water required, owns by purchase in the Owens Valley more than 140 square miles of territory. As a part of the aqueduct system, five large reservoirs are to be constructed, one 35 miles above the in-

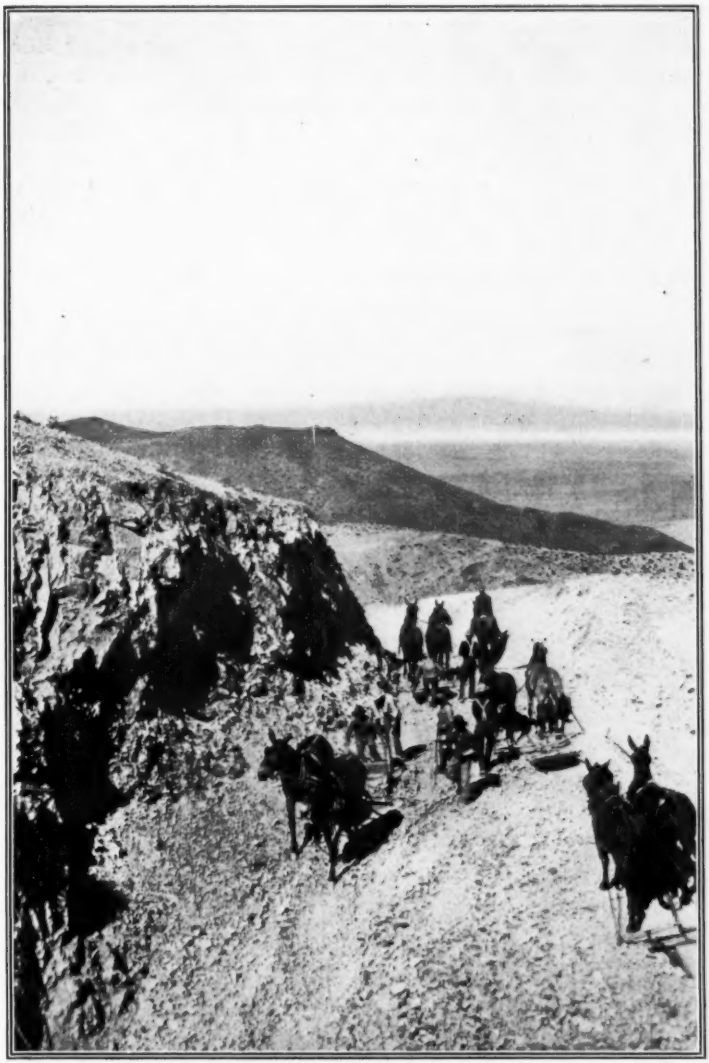
take to impound flood waters, another 60 miles below the intake for clarifying and storing the seasonal discharge, a third at the foot of the Coast Range in the Antelope Valley for regulation when the power plants are in operation, and two in the San Fernando Valley for impounding and distribution purposes. This system of reservoirs will have an aggregate capacity of 376,256,000,000 gallons. The water as it comes from the snow fields of the Upper Sierra is of the purest quality, and contamination by human agency is well guarded by the large property holdings and the extensions of the Government Sierra forest reserve in the valley.

In the two years that work has been under way, the most difficult features have been overcome to a large extent. A steam railroad 120 miles across the desert, for which there was absolute necessity, was begun a year ago and is now three-fourths completed and in operation for 80 miles. This has satisfactorily disposed of the problem of transportation of men, stock, and food supplies, and the 1,000,000 tons of cement, steel, lumber, machinery, and other materials needed. It is true that this railroad lies in some instances 1,200 feet below the line of the aqueduct, but more than 100 miles of well ballasted road, some of it blasted out of solid rock at a cost of $5,000 per mile, have been built; and over these highways the freighting is being done with caterpillar engines. These are a peculiar type of traction engine first used by the English in the South African war, which have been altered and improved to meet aqueduct conditions.

For water the mountains have been prospected, springs developed, pumping machinery installed, reservoirs built, 90 miles of pipe lines laid, and today wherever the forces of the aqueduct are engaged, an adequate supply of pure water is available.

One of the obstacles encountered from the first was the high cost of operation of steam machinery due to the long transportation of water and fuel. To obviate this the dormant energy of two of the mountain streams of the Owens River country has been utilized. Three hydro-electric power plants with an aggregate capacity of 3,000 horse power have been built and are now in operation. Over high-tension transmission wires strung along the aqueduct for a distance of 160 miles these power plants supply the motive force which is driving the two hydraulic dredges, electric power shovels, and the equipment used in the many tunnels now being excavated.

To provide against heavy freight charges and the manufacturer's profit on cement, of which 1,180,000 barrels will be required, the city has gone into the cement business. As one of the parts of aqueduct building, Los Angeles is now operating the only municipal cement



BUILDING ROADS IN THE JAW BONE DIVISION, 1,200 FEET ABOVE THE FLOOR OF THE DESERT.

Blasted in the rock; cost $5,000 per mile.

mill in the world, this taking in everything from the mining of the limestone and dredging of the clay to the shipping of the finished product. The plant is admirably situated near Tehachapi, 12 miles from the aqueduct line and midway from Los Angeles and the aqueduct intake. The mill has been built at a cost of $400,000 and has a capacity of 1,000 barrels per day. As a part of this cement-mill property, the municipality of Los Angeles has established a city of the fifth class, where all the townsite is owned by Los Angeles. This is the town of Monolith, the population of which is made up almost exclusively of city employees in the cement mill; it has an excellent water and sewerage system, a church, school, and stores of various descriptions.

For communication, a copper telephone line, 250 miles long, has been built from the aqueduct headquarters in Los Angeles to the farthest point on the aqueduct. Branch lines connect every camp so that at all times the work is under the direct command of the chief engineer, William Mulholland, and his assistants.

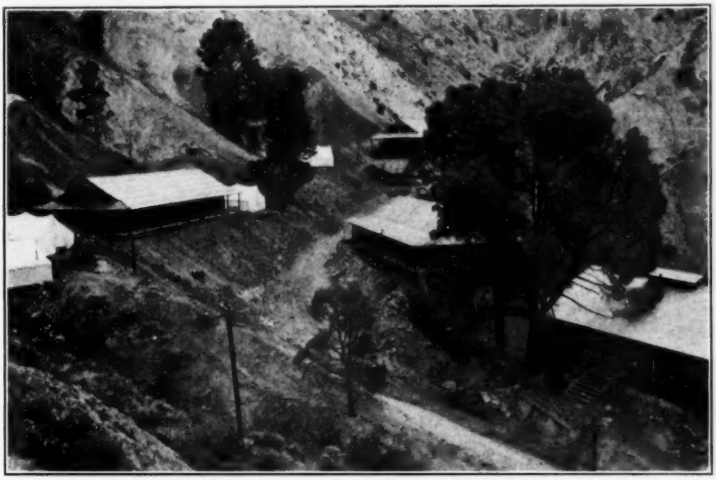
The aqueduct assumes a variety of forms and dimensions in its course from the intake to the San Fernando reservoirs. The first 22 miles it is a canal 50 feet wide and 10 feet deep. The size and shape for the remaining distance are determined by the natural conditions and economic studies of how best to overcome them. However, the approximate average size is 12 feet wide by 10 feet deep, of mono-

METHOD OF CARRYING WATER AND DYNAMITE DURING CONSTRUCTION OF THE GREY RIDGE ROAD, JAW BONE SECTION.

lithic concrete construction, covered for the major distance with a slightly curved top of reinforced concrete heavily girdered. The character of construction is 22 miles of canal, 152 miles of cement-lined conduit, 29 miles of tunnels through rock and earth, 14 miles of steel siphons from 8 to 10 feet in diameter, and 2 miles of flumes. The actual length of canal and conduit is 218 miles, the remaining 22 miles being made up by the lengths of reservoirs. Engineers' estimates call for the excavation of 8,500,000 cubic yards of loose earth and solid rock, and the consumption of 1,180,000 barrels of cement and 23,450,000 pounds of steel.

The elevation of the aqueduct at its intake is 3,800 feet. The elevation of the city hall, Los Angeles, is less than 300 feet. By tunneling the Coast Range, which obviates the installation of costly pumping machinery, the water will be taken in at the source of the aqueduct and by a gravity flow carried the entire distance to points where it is to be used for irrigation or domestic purposes.

The length of time required for the completion of the project is determined by the period necessary to complete the Elizabeth tunnel, 26,860 feet through the crest of the Coast Range of mountains. Therefore the Elizabeth tunnel was started as soon as possible after the bond election of June 12, 1907, at which $23,000,000 in bonds were voted. The south portal was opened in October and the north portal in November of the same year, and in August, 1908, a shaft was sunk 3,000 feet from the north portal. This gives six tunnel



A TUNNEL CONSTRUCTION CAMP ON THE JAW BONE DIVISION.

faces upon which work is in progress night and day with the most modern equipment obtainable. In March, 1909, a total of 7,000 feet had been bored through the hard gneiss rock which makes up the formation of the locality.

PUTTING ON THE COVER OF THE AQUEDUCT.

Excavation of the canal was begun in the same year, but other that at these points, strange as it may appear at first sight, there was not a shovel full of earth turned in aqueduct excavation until October, 1908. The aqueduct engineers occupied more than a twelvemonth in preparation, which included the building of steam and wagon roads, trails, water systems, power plants, the establishment and building of camps, warehouses, bunk houses, mess halls, offices, machine shops, electric power stations, and the one thousand and one other accessories of aqueduct building.

But as soon as the dirt began to fly, the results of the long period of preparation were readily apparent. In October half a mile of aqueduct was excavated, in November 1½ miles, in December 2 miles, in January 2¼ miles, in February 4 miles, and in March 4½ miles. "From now on, we shall do about 5 miles per month," says Mulholland, "and if necessary we can increase the mileage. As the water cannot be carried into the San Fernando Valley until the completion of the Elizabeth Tunnel there is no object in completing the

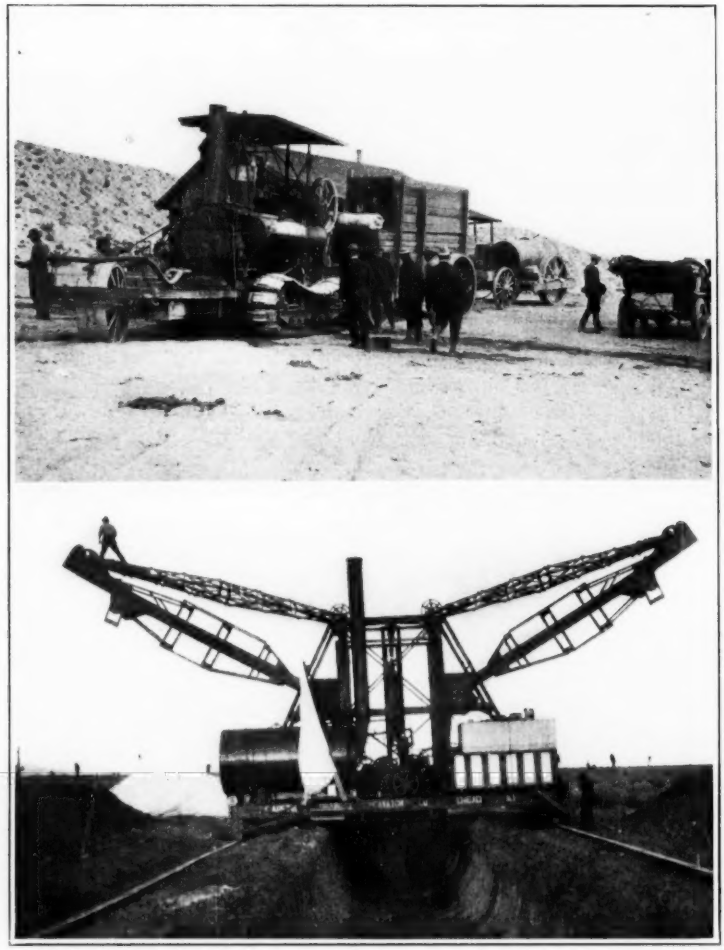
remaining part ahead of time, as this would necessitate the payment of heavy interest charges."

In explanation it should be stated that the second bond issue of $23,000,000 was disposed of to an Eastern syndicate, the city selling the bonds as money is required to carry on the work. Mr. Mulholland's estimate of expenditures for 1909 is placed at $4,500,000, or more than is required in the same interval to carry on all the other functions of the municipal government. Disposing of the bonds in sub-issues of from $2,000,000 to $4,000,000 at a time reduces the interest charges to a minimum.

With the exception of one small contract approximating $529,000 for the construction of 10 miles of tunnel and conduit in the Antelope Valley, the entire work is being undertaken by the city under the direction of aqueduct engineers. At this writing the city's forces are well within the time and cost estimates made by the consulting board of engineers, John R. Freeman, Frederic P. Stearns, and James D. Schuyler (of the Board of Consulting Engineers for the Panama Canal), who investigated and reported upon the feasibility of the project in December, 1906.

AQUEDUCT DIGGING AT BETTER THAN 100 FT. A DAY THROUGH THE FLAT MOJAVE DESERT WITH A "MARION 40."

To do its own work the city was required to defend its rights in the courts. A restraining suit was filed by contractors in which it was alleged that it was contrary to the city charter, and that the work could be done cheaper and quicker under private contract than



MACHINERY FOR AQUEDUCT BUILDING.
Above, the caterpillar engine; 30 of these traction machines are used for hauling over steep and sandy mountain roads. Below, an excavator which finishes 100 to 150 feet of conduit per day to exact shape required.

by force account. In refuting these last arguments the city filed its cost data sheets for the Jawbone division (the case at issue), wherein it was shown that not only was the work being carried on at a smaller figure than the engineer's estimates, but that this was less than one-half the bid of the lowest contractor. As to time, it was

shown the Court that at the prevailing rate of progress the section would be completed well within the time limit which had been set for contractors in the published specifications. With this case decided in favor of the city, preparations were made at once to begin excavation of conduit and tunnel on other divisions.

The working force now numbers 3,000 men and it is expected to increase this to 5,000 before the end of the year. Eighty per cent of the cost of the aqueduct is represented in wages of labor, which after two years of training is well organized and directed. To assist in a closer and more compact organization the aqueduct has been separated into 11 divisions, each from 6 to 23 miles long, with an assistant engineer in charge.

The men are well housed and well fed and are watched over by a corps of physicians, who in addition to being responsible for the health of their charges are held to account for the sanitary condition of every camp. Laborers are provided with sleeping quarters at the expense of the city and are charged $5 per week for their meals. For a year the commissary function was conducted at an exceedingly small profit by the city. The growing magnitude of the work, however, made it imperative that this should be placed in other hands and conducted separately. The contract was let for feeding the men at $5 per week, the quality and quantity of food to be maintained at the same point of excellence as the city was then serving. Violation of these terms, in the decision of the Board of Public Works, brings a forfeiture of the contract 30 days after notification has been given by the city. Under these terms the men are well fed. With the exception of day laborers and several of the higher officials, Civil Service regulations are in force and rigid observance of the rules is demanded. The bureau has thus been kept remarkably free from politics.

The spring of 1913 has been set by Mr. Mulholland as the time at which the waters of the Sierra will be turned into the aqueduct to find their way by tortuous course across the desert and under the mountains to their final destination in the San Fernando Valley. Los Angeles sees the end of her difficulty to obtain a water supply for her constantly increasing population, and the beginning of a new *régime* in which there shall be a plenty, not only for herself but for the smaller towns and cities near at hand. And beyond this, there will still remain enough for the irrigation of thousands of acres of farming and horticultural lands.

The two San Fernando reservoirs will lie near the rim of the valley about 20 miles northwest of Los Angeles. In the rainy season,

THE CENTRIFUGAL DREDGE AT WORK.
Two electric-driven hydraulic dredges are thus excavating 22 miles of canal through the Owens Valley.

which extends from November to the last of April, little, if any, irrigation of crops is required, and these reservoirs are designed to regulate a supply for this varying consumption, small in winter and very large in summer, so that in time of greatest heat or extended drouth, water will be distributed in amounts exceeding the capacity of the aqueduct.

The assertion is made by Mr. J. B. Lippincott, assistant chief engineer and an expert on irrigation, that, if the aqueduct were completed today, there would be a field for every drop of water it is capable of carrying. When it is remembered that the daily capacity of the conduit is 280,000,000 gallons and the domestic consumption of the city only 35,000,000, it is seen that extensive irrigation, probably of small farms, if a legal way can be devised for this, is contemplated. This will necessarily work to the benefit of the city in an increase of land values and taxes, a largely increased population, and the consolidation with Los Angeles of the larger and more prosperous cities in close vicinity. This, indeed, in one instance is now under way.

The possibilities of electrical power development offer even larger direct financial returns than does the sale of water for irrigation, and when the aqueduct is completed, or perhaps before that time, new bond issues will undoubtedly be authorized by the people to carry out this feature of the enterprise.

APPLICATIONS OF CONCRETE IN THE METAL-MINING INDUSTRY.

By Henry W. Edwards.

Mr. Edwards' article is devoted to a description of recent work, entirely new, with no recapitulation of experience already made public, but with very interesting and useful comment on the conditions met with in the preparation and use of reinforced concrete in mining, and the methods that have proved successful in practice.—THE EDITORS.

IN no class of engineering work, probably, is the engineer more dependent on his own resources than in the case of a mine in a remote district, far from the ordinary means of transportation and the conveniences of civilization. Scattered over the American continents from Cape Nome to Cape Horn are many petty kingdoms, as it were, in which the mining engineer has to be the sole source of all knowledge in his little district; his responsibilities are without limit and his duties comprise everything. He is called on to exercise a more or less profound knowledge of surveying, mechanics, hydraulics, electricity, mineralogy, assaying, metallurgy, construction of roads, and to know all there is to know about wire rope, explosives, pumps, and geology. It now seems that a knowledge of the uses and capabilities of concrete ought to be added to this already formidable list. Although the great bulk of the mineral production is derived from a comparatively small number of large mines in complete touch with civilization, yet far the larger number of individual mining engineers find their work far removed from the conveniences and facilities of the larger and more established camps. It is from the point of view of the isolated engineer that this is written.

Concrete, used for the mere purpose of supporting unsafe ground, is gaining but slowly in favor, being confined for the present to an occasional tunnel portal, to lining shafts through surface soil down to solid rock, and to a very limited use of "stulls." In the coal-mining industry much greater use is made of concrete for all purposes; but it is not the intention in this article to touch upon that branch.

The chief advantage of concrete for lining shafts through the surface soil and down to bed-rock, outside of its durability, is its efficiency in keeping out water. The upper part of the lining is usually

so shaped and extended as to form the foundations for the hoisting machinery. The rounding shape, or arched effect, shown in recent illustrations published, is of no particular advantage for vertical shafts, although it is quite necessary if the lining be made of brick or stone. Even in small mining operations, if the surface soil be wet no time should be lost in protecting the shaft with a water-tight lining, which should be extended upward above the floor line sufficiently to form a kerb around the mouth of the shaft to prevent the rain water or rubbish from falling in. Arrangements for supporting the ordinary shaft equipment of cage-guides, ladders, pipes, etc., must be well thought out beforehand in order to avoid having to cut into the concrete after it has set. Shaft linings are comparatively simple in vertical shafts, but inclined shafts do not lend themselves quite so easily to placing the forms and ramming the concrete, but not even these require any very high order of ingenuity. In this latter case the upper part had perhaps better be made arching and, if possible, reinforced either with specially purchased iron or with whatever old material may be available on the spot, such as old rail or pipe. A neat method for shaft lining is to make slabs of concrete three or four inches thick by two or three feet square, which when properly hard are placed and supported against the sides of the shaft, the space between them and the soil or rock being filled with concrete well rammed in; these slabs are left permanently in position.

It is as a means of controlling water underground that concrete is growing in favor rapidly. It is a much better stroke of business to keep water out of a mine than to pump it out. As an instance, at the Candelaria mine, in Mexico, the great influx of water was found to be at a point midway between the first and second levels, about 160 feet from the surface. A portion of this water was very ineffectually trapped on the second level by means of wooden troughs and pumped thence to the surface, but the great bulk of the water found its way to the bottom of the shaft at 700 feet. Raising the water from this depth to the surface necessitated a continuous effort at the pump to overcome some 630,000 foot-pounds. What with condensation in such a long steam line, pipe friction, etc., this amounted to something over 30 horse power at the boiler. It was therefore decided to arch over the second level from the shaft completely to the end. This being done, the water, thus completely confined above the arch, was pumped only 200 feet to the surface. The pump at the bottom of the mine was then able in a few hours work per day to take care of all the water seeping into the mine below this level. The saving

in reality was found to be more in money than was represented by the steam saved, the men being much more efficient in the more agreeable circumstances, besides the heavy bills for repairs to the pump being much diminished. The forms used in this work consisted of two segments from an old steam boiler, lapped over one another to a greater or less degree to accommodate the variable width of the level, the smaller irregularities being closed by scraps of boards or sheet iron or anything else that came handy. As elegance and finish are not considered necessary underground the marks left by these were not smoothed off. The preliminary work, having for its object the preventing of the water from washing over the wet concrete, was much more difficult and engaged much more attention than the mere construction of the arch.

At the San Blas mine, also in Mexico, in sinking a shaft 8 feet by 12 feet in area, a heavy flow of water was encountered at 90 feet from the surface, through a fissure which crossed the shaft at about a 25-degree angle. The flow of water was such that in spite of the most energetic efforts only 8 feet of progress was made in a month. We therefore enlarged the shaft, in an irregular outline, for two or three feet on each of its four sides for a belt of about three or four feet above the fissure and about the same distance below. After the water had risen to its natural level in the shaft, some 250 tons of concrete were dumped in and allowed several weeks to set. The water was then pumped out and the shaft re-excavated through the concrete and carried down to 400 feet without further trouble. Had a central hollow core been left in the concrete the work of sinking through it would have been very much diminished. The total cost of this work did not exceed $2,200, including the re-excavation of the shaft, the cement costing, delivered at the spot, $4.50 per barrel.

It may be as well to indicate the precautions necessary to secure a successful issue to a piece of work of the above sort. First, the water should be without movement, or the flow be at least imperceptible. For this reason the shaft was allowed to fill up to its natural water level. Second, the concrete should not be dumped in and allowed to fall to the bottom, causing a separation of the heavier from the lighter ingredients. In the case cited the concrete was lowered in a wedge-shaped bucket, one side of which was hinged at the top and fastened at the bottom by a latch to which was attached a wire leading to the surface. When the bucket was lowered and placed as nearly as possible in position the wire was pulled, releasing the concrete without giving the cement much opportunity to separate from the

other ingredients. Third, the re-excavation must be made without the aid of explosives. Fourth, ample time must be allowed for the concrete to solidify.

At another mine, water entered at a point where the vein crossed a considerable stream. On occasions in summer time the bed of the stream ran dry. At such periods the mine pump was almost idle. During one dry season I had the bed of the stream cleaned of all boulders and sand and other loose material for about 10 feet up-stream and the same distance down-stream above and below the vein crossing. This space was then covered with a pavement 6 inches thick, effectually and permanently doing away with nearly all the pumping expenses.

A good instance of how not to do a job of this sort was at the Herrarias mine in the South of Spain. The river Almanzora runs through the property, and in following a small vein of rich silver ore the river water gained entrance into the workings. A ship load of cement was dumped into the river, being thrown at random over the ship's side over the place where the leak was supposed to be—but, of course, absolutely without effect on the mine pumps. The final result was that a valuable mine was abandoned for a number of years.

For "timbering" underground, concrete "timbers" are attracting a certain amount of attention. The average life of a pine timber or stull in a mine may not be counted on to exceed four years, while the life of a concrete "timber" is indefinite; it costs more in the first instance and, owing to its weight, it is more costly to place in position. Concrete timbers are easily made in long wooden troughs, or in split tubes of sheet iron, with the ends adjusted so that they can be changed to suit the desired length and angle of cut. If it is possible to do so, the form should be set close to where the stull is to be finally placed. The conspicuous disadvantage of the concrete stulls is the difficulty in placing them at the proper angle with regard to the line of thrust of the ground to be supported. Frequently when the ground being supported settles to a small extent the angle of thrust is greatly changed; in such a case a pine timber is easily wedged up, or the ends cut to a new angle, or the position of the whole thing changed to suit the new conditions; once a concrete timber is in place any changes are very difficult. Up to the moment of writing, the greater use of concrete stulls and timbers is in replacing rotted ones. In this case, the ground having already settled and the wooden stulls having been subjected to observation for a considerable period of time, the con-

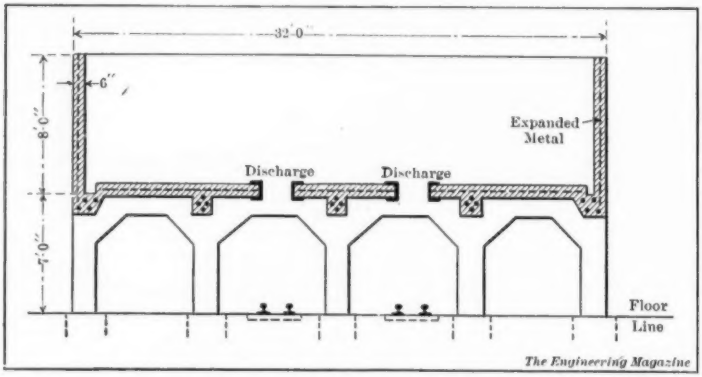
crete props can be placed with more intelligence, not only as to the direction of the lines of force but also as to the amount of strain they are to be called upon to resist. Both of these factors are usually only partially known in the first instance.

As a general proposition, the use of reinforcement, either of scrap material or of some one of the many special shapes of iron, is not very usual for underground work in the metal-mining industry. For surface structures, however, we follow all the usual rules of such constructions. Portions of the various structures in which the stresses are exclusively in compression do not require reinforcement.

These statements suppose the use of cement of good quality, which, in out-of-the-way places, is not always obtainable. It is of very little use to attempt to test the cement for the purpose of comparing the results obtained with the figures obtained by the manufacturers. So many factors are not uniform with the conditions under which the experiments are made at the factory that the final results are quite different. The age of the cement, difference of temperature and humidity of the air, of the water or of the cement itself, and even the nature and amount of the various mineral substances dissolved in the water, all together introduce such differences as to make it a waste of time to make any other tests than the actual mixing and laying of a small preliminary batch of concrete. About the only exterior indiction of defective quality is the swelling of the barrels when they have been too long in stock in a humid climate or have accidentally been wetted. It seemed a pity that no way could be found to stamp each barrel reliably with the date it left the factory, like the photographic supplies. Several years ago a few shiploads of cement made in Russia (in Odessa, I believe), were distributed along the west coast of Mexico and the Central American republics. Quantities of this cement are still in stock for sale in the hands of almost every merchant along the coast. This was not a bad cement on its first arrival, but long storage in a tropical and humid climate made it quite useless. As a rule the mercantile houses, particularly the Latin-American ones, look not to grade and keeping quality, but to the terms and conditions of purchase. The manufacturers might help a little by packing cement intended for tropical countries in special packages for the purpose of excluding moisture. If it be possible, the engineer will do well to purchase his cement direct from some manufacturer of a standard brand and not to depend on purchasing from local merchants.

As a general rule there is nothing at any mine in the way of sur-

face structures that cannot be made, and better made, of concrete than of any other material—head frames, ore bins, floors, buildings, electric-wire poles, trestles, water pipes for low pressure, boiler settings, chimney stacks, tanks of all kinds, and even boats and lighters if the mine have use for these latter.



CYANIDE VAT OF REINFORCED CONCRETE.

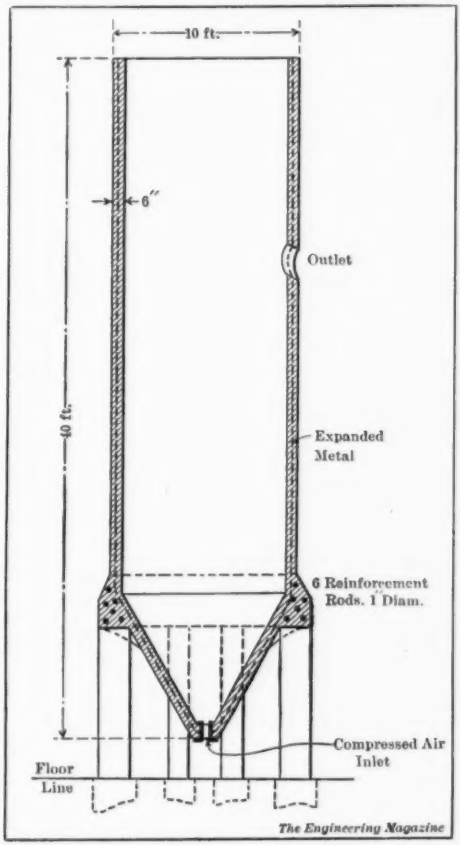
As to head frames; the strains of hoisting are converted entirely into compression in these structures and concrete is, therefore, exceedingly appropriate. One of the most satisfactory head frames I have put in had for its principal members two old sheet-iron smoke stacks, each 28 inches in diameter by 50 feet high. These were filled with concrete, section by section. As just remarked, all the strains in these structures being resolved into compression in the direction of the resultant of the engine pull and the ascending load, it would appear that a head frame need consist of a single strut only, placed in the plane of this resultant, and that any other members would be superfluous except such feeble ones as might be necessary to support the main strut in the proper attitude while not in use. Concrete head frames are cheaper than steel and, moreover, are not subject to the violent and unpleasant vibration of the steel construction. This vibration may be done away with entirely by casing the steel structure with concrete.

In the making of tanks for water or for the cyanide process or for slime settlers, reinforced concrete is most adaptable. Recent changes in the manipulation of the cyanide process have involved the use of tanks which rather puzzle the wooden-tank manufacturer, particularly those tanks with conical bottoms. The maker's difficulty in these

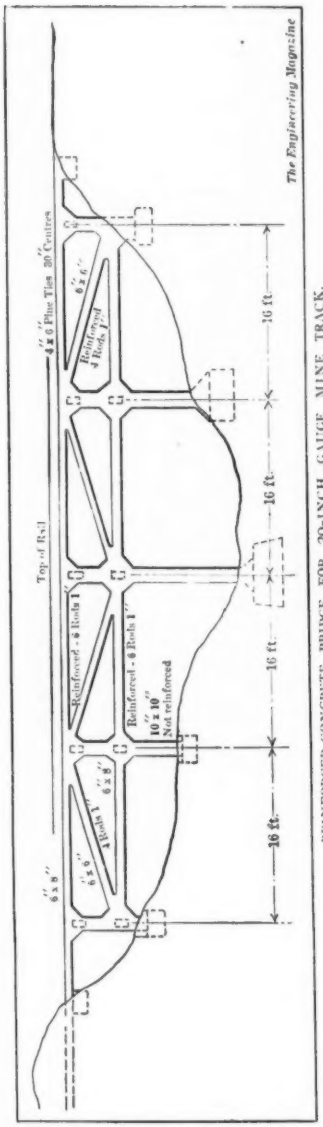
tanks comes in keeping the hoops from slipping down the conical part, or in finding any really satisfactory substitute for hoops. For the concrete man these difficulties do not arise; he has no bounds of shape nor size nor position, nor is he called upon to handle material of unusual dimensions nor, like the iron-tank man, is he obliged to send a gang of riveters, say from Pittsburg to Nicaragua, to rivet up a set of tanks shipped in sections.

Another essential part of the cyanide plant is the system of launders or troughs for conveying the solutions from tank to tank. When made of wood these launders are not difficult, so long as they are straight; but when curves or junctions become necessary, then the difficulties of making them absolutely water-tight begin. Concrete launders can be made as complicatedly crooked as may be convenient, with perfect freedom from leakage and, moreover, if allowed to dry they do not shrink, like wood, opening up cracks where none previously existed.

The former method of building cyanide tanks was by lining, with heavy concrete excavations partly or wholly below ground level. The modern reinforced-concrete cyanide tank is an elevated structure upon concrete pillars, with its bottom and all its other parts as



REINFORCED-CONCRETE CYANIDE VAT, PACHUCA PATTERN.



REINFORCED-CONCRETE BRIDGE FOR 20-INCH GAUGE MINE TRACK.
For mule hauling three cars, each 1,500 pounds net load.

accessible to inspection and repairs as an iron or wooden tank. In the modern construction of cyanide tanks, "expanded metal" or a system of iron rods and wires forms the reinforcement; the concrete, some 6 inches in thickness, is thoroughly trowelled over with neat cement on the inside in order to close up the pores of the concrete. Any offsets or fastenings for filters or outlets or inlets are all provided for in the wet concrete. Should small cracks develop so as to expose the iron reinforcement to contact with the cyanide solution, no harm will result as the solution is entirely without action on iron. A good preliminary paint coating may be made by emulsifying soap and water and kerosene oil (in about equal weights of the three ingredients), after which the tanks may receive two coats of the usual paint sold for cyanide work.

The "pointed boxes" and other similar appliances used in the concentration mill are made in a similar manner with expanded metal, or rods and wire, and may be relied upon to give better service than either wooden or iron apparatus. For dressing ores, concrete made with a smooth finish of neat cement offers an excellent surface to which some minerals appear to cling more than others. I had in use in Arizona two revolving "buddles" of 12 feet diameter made in this manner. The ore there con-

sisted of several minerals, among them a copper-gold-silver mineral, valuable, and a zinc-sulphide, valueless. In passing the crushed ore over the buddles for washing off the rock matter, it was noted that the proportion of zinc sulphide gotten rid of on these machines was greater than in any of the other appliances in the mill.

Trestles for the ordinary mine tramway are very striking instances of the advantage of reinforced concrete, especially in districts where timber has to be transported great distances. The difficulty and expense of carrying long timbers for the chords is enormous as compared with the carrying of cement, and the differences become more and more evident as the distance increases, and finally the timber becomes prohibitive when mule-back is the only means of transportation. Only about 15 per cent of the bulk of concrete consists of cement to be transported; the balance, gravel or crushed rock and sand, ought to be obtainable at any mine without any further expense than gathering it up on the spot. Attention is called to the advantage of designing these light bridges or trestles so that the whole structure forms a jointless, continuous, trussed girder, and with a view to making them self-supporting in the event of one or more of the legs being washed out from under by floods. It is only necessary to reinforce those parts subject to stresses of tension and shearing, the thin material usually employed for reinforcement being of little or no help against compression. To sustain the ordinary mine track using a car moved by man power, supports 16 feet apart, and chords 6 inches by 8 inches, are ample. Forms for this class of small repetition work are most conveniently made of No. 16 sheet iron nailed to a framework of 2 by 4 scantlings.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

II. Production Factors as Related to Cost Accounts and Staff.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The preceding paper was devoted to "The Definition of Factors other than Labour."—The Editors.

THE object of organisation is to determine the ways and means of efficient production; the object of cost accounts is to register and record every stage and step of production as they actually happened. It is very necessary to insist strongly on this latter definition. Costing should be registration of production—events that have actually happened—it should be nothing else. But when such facts have once been faithfully and accurately recorded, then they may be interpreted in several different ways, according to the needs and the point of view of the person interpreting them.

The necessity for insisting on the apparently elementary statement that costs are records is justified by the tendency of some writers to define estimates as costs. Even so eminent an authority as Mr. Harrington Emerson has recently stated in these pages:*

> There are two radically different methods of ascertaining costs, the first method to ascertain them after the work is completed, the second method to ascertain them before the work is undertaken.

I venture to think there is a confusion in nomenclature here. One cannot "ascertain" a cost in advance, although it may be perfectly feasible to "estimate" it more or less closely. As a matter of fact, in this particular instance Mr. Emerson's estimated costs are afterwards checked and compared with ascertained or actual (i. e., real) costs, and the discrepancy between the two is interpreted as "waste."

It is very important that costs should not be regarded as something that may be manipulated, nor should they be thought of as representing anything but the cold truth, however unwelcome that may be. Unless we have confidence that our costs do, in fact, truly represent

* Efficiency as a Basis for Operation. The Engineering Magazine, Dec., 1908, p. 336.

what was happening in the shops on a given occasion, it is possible neither to compare them with estimates of what they should have been, nor to deduce valuable lessons for the future from them.

But if our costs represent the actual facts of production and the actual results of our form of organisation, then there are several uses which may be made of them. Amongst these may be mentioned:

1. The financial or accountancy use, as showing how money was expended.

2. Comparison with estimated results, as in Mr. Emerson's method, the discrepancy between estimated and actual results being regarded as "preventable waste."

3. The technical use, showing the cost of every process on every part, enabling a close check to be made upon efficiency of production.

4. Use as a basis for fixing premium or bonus rates.

5. The commercial use, as a basis for fixing remunerative prices, and for selecting that class of product that can be most profitably manufactured.

The first of these uses—the accountancy use—demands very little detail. Its requirements are met by broad classifications into "productive" and "non-productive expenditure," and the subdivision of these classifications is rather a matter of fancy than of real use. Elaborate scheduling of expenses is not infrequently undertaken, without any real use being made of the figures. The proper attitude of the accountant towards costs should be that of regarding them as details of "control accounts" with which their aggregate totals should agree. He should not attempt further classifications that can be more efficiently obtained from the detailed costs themselves when interpreted by those technically competent to do so.

The remaining uses of costs all depend upon accurate determination of the fractional costs of parts. It would be an excellent thing if it were established as a fundamental axiom of cost accounting that *the cost of a machine is the aggregate of the costs of every process on every part, plus the value of the material.*

A few years ago this would have appeared an impossible and idealistic definition. The modern tendency to plan out, schedule, and specify everything in advance is rapidly making the "process" the starting point of all organization, and therefore necessarily of all costs.

It is at this point that we come directly into contact with the question of production factors. Material presents but few difficulties. Its cost is easily ascertained. But before we are in a position to give the cost of every process on every part it will be necessary to determine, first, what we mean by the cost of a process, and secondly, how far we

can express our meaning in actual figures. It may be well to put this in the form of a definition, as follows:

The cost of a process is the aggregate of direct labour cost plus the cost of the various indirect "services" to production (or production-factors) which are necessitated by the form of the organisation.

Whether or not we can succeed practically in regarding all shop expenditure in the light either of direct labour or of "services" rendered to production, it is the object of these articles to examine; but assuming for the moment that it can be done, it will be admitted that process cost as defined above is necessarily the proper basis on which total costs should be built up. It will be seen that the cost of a process on a single part becomes a perfectly definite and tangible thing and can be recorded as such. The tendency to regard burden or indirect expense as something that should be "averaged," manipulated or juggled with, disappears. But there will still be left, and under any possible system of organisation and any possible method of costing, there always will be left, the problem of the "penalised" job.

Fluctuation in Direct Costs.

By a "penalised job" is meant a piece of work that from exigencies of the moment is done by a more expensive man or on a more expensive machine than normally needful. Many persons think that an ideal system of costs should represent the cost of such a job *as it ought to have been* rather than as it actually was. The point is an interesting one, and obviously needs to be discussed and cleared out of the way before we can claim that any proposed system of costs is truly representative of facts.

It must not be forgotten that the "penalised job" always represents inefficiency of organisation. Mr. P. J. Darlington has recently* put the case for the penalised job in these words:

> A very large proportion of machine work is done on tools much larger than necessary for each operation. This is usually for good practical reasons, such as to keep otherwise idle equipment and operators profitably employed . . . evidently indirect cost must be based on the indirect rate *normal* to the operation rather than on the rate of the tool on which the work happens to be done.

Now if this is a fair statement of the case, if a large proportion of processes are carried out under inefficient conditions, then it would seem that the only thing to do is to represent, in the costs, what actually happened. If owing to the equipment being out of proportion to the work done on it, systematic inefficiency results, no amount of explaining the matter by reference to "good practical reason" will

* Principles of Works Management. The Engineering Magazine, April, 1908, p. 65.

either bring the equipment into closer harmony with the work, or reduce the actual cost of the processes as carried out. Whether a more expensive man or a more expensive tool was used than actually necessary, it seems a very dangerous proceeding to misrepresent in the costs what actually did take place. Once the principle of "what ought to have been" instead of "what was" becomes introduced into records of any kind, they rapidly degenerate to the value of waste paper.

It is admitted that the question presents peculiar difficulties. In a shop wherein large machines were frequently used to do the work of small ones, several things might be done. (1) The "normal" instead of the actual cost (if it were known) might be charged in costs and the balance placed to an "inefficiency account." (2) The large tools might be sold and replaced by others better adapted to the work. (3) The large tools might be left, and new ones purchased suitable to the general run of the work. Let us glance at these alternatives.

(1) Charging the "normal" rate instead of the actual in the costs would be a very dangerous proceeding, and would give no new information as to the condition of inefficiency. It is true that the "inefficiency account" would call attention to the condition obtaining in the shop, *but not more urgently nor more forcibly* than would the higher process costs on the regular method.

(2) It might be impossible to part with the large tools, and in such a case the inefficiency remains as a regular feature of that particular shop's working.

(3) If the old tools were left and new ones added, the general efficiency would not be raised, because the idle burden on the old tools would continue to fall on the shop as a whole.

This matter has been discussed at some length because it involves an important principle, viz., whether costs shall be actual records or only guesses and informal memoranda. In the case cited it is obvious that inefficient conditions exist in the shop, and nothing can remove them. The only question is whether the costs shall reflect exactly what happens, or whether some attempt shall be made to make things "look pretty" by covering up part of the truth. In view of the very grave dangers attending the permission to vary the truth of such records, it does not seem that the advantages to be gained by smoothing down and rounding off "penalised" jobs are worth the trouble and risk, even were it proper from a theoretical point of view to do so.

That it is not proper from a theoretical standpoint to tamper with and adjust costs under such conditions there can be no question whatever. If a higher priced man than necessary is given the job just because he happens to be there, his wages pass into and become part

of the cost. Very few persons would have the hardihood to suggest that *wages* should be adjusted and averaged. But it is equally true of a machine. The moment we put a machine in work the production-factors of that machine are passing into the cost of the work. We are using up the machine and using up the power that drives it just as well on a small job as on a larger, and probably in no less degree. Machine rates differ in proportion as machines are large, heavy, and costly, or small, light, and cheap. If we set the larger of the two in motion, on whatever job, it is just as fair that the job should bear the cost, as it is fair that the job should bear the cost of the higher wage rate of an expensive man.

It does not seem worth while to depart from the actual representation of facts to obtain—what? Estimated or "averaged" costs on the one hand, and on the other an "inefficiency" account which would teach less clear lessons than intelligent reading of the actual process costs themselves. For the present, therefore, and until there is some new method of representing departmental inefficiency as expressed in production factors (or any other method that attempts to connect real manufacturing expense with work done), or even in prime or flat costs, we must be content to see that inefficiency expressed in a higher cost of the actual job done under the inefficient conditions.

Fluctuations in Burden.

While it does not seem proper to relieve "penalised" jobs of the extra cost entailed by the conditions of inefficiency under which they have been performed, the limits within which such costs will fluctuate are not very great. No previous planning will reduce the actual cost, though it may help to explain the reason for any small increase. But when we come to consider fluctuations in burden or establishment charges, altogether different possibilities are found to exist. The problem of violent fluctuations in burden has always presented peculiar difficulties, and has afforded the best arguments for the school of thinkers who support the principle of "averaging." A question frequently asked, for example, is whether building repairs should be charged in the month or period of their expenditure by means of an increased burden, or whether they should be held over in a "suspense account" and gradually filtered into the distributed burden over a longer period.

As long as we are content to consider building repairs as connected in some mysterious way with the productive function, such questions will always present many opportunities for argument. If there is any relation between such expenditure and direct production, and if it is capable of being intelligibly expressed by a percentage, then such

problems have every claim on our attention. But no such relation exists, because the expenditure on building repairs and the expenditure on direct production belong (as already outlined in the first article) to two entirely different functions of the manufacturer—viz., his function as property owner, and his function as producer.

It is at this point that the principles of planning out, of estimating in advance, even of "averaging," come into full play, yet in a totally different sense from their exercise upon the mingled phenomena of the works, where every expenditure is classed as "productive" or "unproductive" and it is sought to express the latter as a percentage of the former. In the method of organisation by production factors it is sought *to isolate as many as possible of the special functions exercised by the manufacturer, to determine their steady and regular rent-value, by foreseeing their fluctuations, and charge these rents as regular production factors of perfectly determinable value.* It follows, therefore, that on this method a large number of expenses commonly regarded as closely and individually bearing on production are entirely removed from such connection and transferred to other groupings whence they influence the cost of production in a much more regular, separate, and distinct way.

It may be asked how this arrangement is justified and how it squares with the principle laid down at the beginning of this article, that "costing is a registration of production events that have actually happened, and it is never anything else." The answer is that the production factor method isolates direct production costs from the confusing influence of a number of other expenditures, and enables the true facts of production to be much more clearly realised than before. Production cost is registered precisely as the events that determine it happened, but the indirect services which go to make production possible, but are not in themselves part of production, are reduced to common values just as the rents of a row of houses are the reduction to a common value of a variety of heterogeneous expenditures by the house-owner. The accuracy of these common values, which thus become production factors, depends, it is true, on prevoyance, valuation, and planning; but that is not to say that these values or factors are in the least arbitrary or of the nature of guesswork. They are in the nature of hiring or payment for definite services, many of which might even be rendered by other persons or contractors instead of by the manufacturer to himself.

Production Factors and Staff Organisation.

In the illuminative series of articles already referred to above, Mr. Harrington Emerson has recently demonstrated the difference between

"Staff" and "Line" organisation, and has shown how important it is that the latter should be supplemented by the former. If staff organisation is, as yet, scarcely beginning to be adopted, notwithstanding its very obvious advantages, it is perhaps because up to the present the forms of organisation have been such that the necessity for it remained unrealised. From the point of view of those who (to use an example already familiar) have been in the habit of regarding building repairs as incident on the cost of manufacturing screws, the idea of staff organisation is necessarily difficult of realisation. But if, long ago in the history of manufacture, "Organisation by Production Factors" had been the universal form, then, I venture to think, staff organisation would have suggested itself as the natural complement of the existence of such factors.

The moment we cease to mingle and diffuse expenses that have nothing in common, the moment we isolate, on the contrary, all expenditures capable of isolation, and bring clearly into view their factorial nature—then it becomes obvious that the next step is to seek to reduce such factors by expert supervision constantly alert for opportunities.

While, for example, we look at the cost of power as a number of "analysed" items such as coal, water-rate, ash removal, drivers' and stokers' wages, etc., it will probably be a long time before it dawns upon us that all this expenditure can be reduced to a horse-power-hour rate, and that such a factor, once known, may turn out to be a standing reproach. The burning of 200 tons of coal per week may mean anything or nothing, but the cost of a horse-power hour can be compared at once with standard data, and will call either for self-congratulation or loudly and imperatively for the services of an expert. In any case, once a factor is known, the temptation to reduce it is constantly present, and staff organisation is obviously the natural way of securing that it shall be done.

As soon as we recognize that *all* the operations that go on in a large works are not productive, nor even *directly* connected with production, but that some of them represent separate and distinct functions exercised for convenience by the manufacturer, so soon shall we realise that each of these separate functions requires expert guidance and is the proper subject of staff activity in Mr. Emerson's sense.

It may even be claimed that production factors give a wider economic value to staff organisation, inasmuch as they enable standards to be set up not only as between today and yesterday in the same works, but as between different works in different places. There can be little doubt that the introduction of production factors and the pub-

lication of figures based on them would reveal amazing inefficiencies that under present conditions are unsuspected and unknown because no means of comparison exists. At the present time all such inefficiencies are covered up and hidden in the general term "Expense Burden" or "Establishment Charges," which does not define anything capable of being compared as between different works. Labour costs and rates of wages can be compared, but when we come to speak of burden or charges, no one knows what the term may or may not include.

To say that burden amounts to 100 per cent of wages or 6 pence per man-hour in one works, and 125 per cent or 8 pence per man-hour in another, conveys no meaning as far as *comparative* values are concerned, because under the existing want of standardised practice no one can guess what such statements really mean. The only use, therefore, that can be made of systems of connecting burden with costs, at the present time, is to compare different periods of operation of the same plant or works. Reduction and standardisation of expenses will go hand-in-hand when once the purely productive functions are isolated from the others, and these latter made the subject of careful and expert study.

The Identification of Production Factors.

Generally speaking, the method herein advocated consists in isolating each function of the manufacturer not directly productive, and reducing them to unit-values, based not upon the accidental circumstances of the organisation, but on an absolute or standardised basis, so that comparison will be possible between different undertakings to a much greater extent and embracing a much larger share of the total activity than at present. For the purposes of practical distribution these unit values will become components of machine rates (with an overflow into a supplementary rate) as arranged under the A. Hamilton Church system of expense-burden distribution already published* but apart from this, they will have separate value and significance.

The desirability of reducing production factors to separate standardised unit-values was suggested by the curious fact that the same machine working in two different shops was found to have a different machine rate in each shop. This was due to the fact that several items of indirect expense were higher, the building being old and requiring much expenditure, while the power costs were found to be unusually high. The cost of manufacture in one of these shops was actually greater than in the other, a discovery that led to useful reforms. But the necessity for fixing attention on production factors first and foremost was also strongly demonstrated In the remainder of these ar-

* Distribution of the Expense Burden.

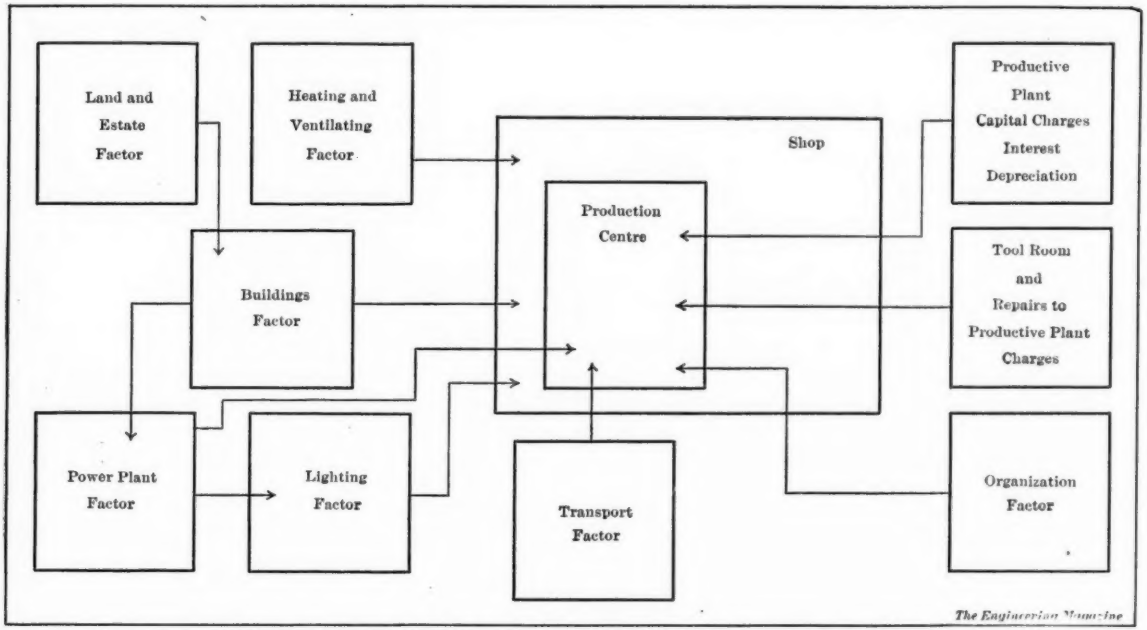


DIAGRAM SHOWING THE PRINCIPLE OF ORGANISATION BY PRODUCTION FACTORS.

It will be seen that some of these are incident on floor space and others directly on production centres, which may be a machine or bench, or a plain floor area in an erecting shop or foundry. Those incident on floor space are reduced to a charge per square foot and enter in that form into the production-centre rate (machine rate). It will be noticed that each of these factors represents a special kind of "service" rendered to production, reduced in each case to a unit value. The indefinite nature of a large number of "indirect charges" is thus replaced by a limited number of definite "rent charges," called herein "production factors."

ticles, therefore, the question of how the production factors affect cost through the machine rates will not be much dwelt upon, the information previously published on this subject being practically unaffected by the results of the present enquiry, which is concerned with isolation and collection rather than the distribution of burden factors.

The diagram shows the general principle involved. Every expense, whether in the nature of standing charges such as interest depreciation and insurance, or current expenditure such as repairs, renewals and maintenance, is charged directly to the production factor with which it is concerned. Such expenses, therefore, are not mingled with each other, or with the actual manufacturing costs. Being expenditure on separate functions, they are kept separate, treated in separate books of account, and considered, in fact, as a different class of operations—which they undoubtedly are.

This method sweeps away the greater part of the elaborate classifications found necessary when indirect expenses are dealt with by analysis and percentage. It substitutes a few clearly marked and easily understood lines of activity for a number of fine-spun ones. No source of information but the job order being recognised for the compilation of accounts, it is a comparatively simple matter to charge each job to one of the few accounts required.

After these broader groups of activity are dealt with, there will obviously remain minor charges which are not of sufficient importance to be made into separate factors, or of which the character is difficult to distinguish from actual production. Such charges are treated as a "supplementary rate" which also absorbs unallocated factors due to idle time of production centres. The rise or fall of this rate becomes a measure of shop efficiency.

In commencing to establish a works or factory the first consideration that presents itself is the site. No uniformity of practice with regard to sites is likely to be attained. We may commence by purchasing a site or by renting one, or we may purchase a portion and rent a portion. But evidently the land-factor, that is, the annual expenditure due to the necessity for holding ground, antedates all other factors. The complexities found in practice tending to make such land factor, and all subsequent factors, difficult of determination, will be dealt with in detail in subsequent chapters—it will suffice now to give a general idea of what the more easily recognised factors are.

Having secured the land, the erections and buildings necessary to the business claim attention. These may exist already or may require to be designed and built. Those already erected may require exten-

sive alterations or repairs. We may rent part of the buildings and erect some additions. Those rented may be taken on a repairing lease of greater or less stringency. But however acquired, buildings have to be maintained, and in some countries, as in Great Britain, statutory cleansings and whitewashings have to be carried out periodically. All these items, and others like them, form a considerable group of expenditure, entirely worthy of complete isolation, for they represent a function anterior to, and separate from the actual productive function. The total expenditure on such function is capable of being reduced to absolute standard data, forming a buildings factor.

In almost every kind of manufacturing business the question of power is an important one. The cost of boilers, engines, cooling towers, and other auxiliary appliances, obviously comes into the power factor. So also does the cost of land which the power house and other apparatus occupies, the cost of buildings, factory chimnies and other erections, cost of coal, wages, water, ash-removal, and similar items—all these contribute their portion to the ascertainment of a power factor, just as though the power instead of being generated on the works were rented from a supply company.

The lighting and heating services are the subject of similar treatment.

In many cases the services of craneage, haulage, conveying, and similar work are of sufficient importance to form a transport factor.

Production-centre factors are those peculiar to each production centre (which may be a large and heavy machine tool, a pattern-maker's bench, or even an empty area of floor in an erecting shop or foundry) and consist of interest and depreciation on the capital value, and various subfactors representing tool-department services, and the maintenance and repair of the plant, if any.

An organisation factor isolates the wages of cost clerks, time-keepers, and other employees solely or partly occupied on organisation costs, together with the cost of books, forms, cards, time-clocks and special appliances. This factor, if worked out for a number of different establishments working under different systems, might be expected to reveal remarkable differences in efficiency.

In the ensuing article each of these separate groups will be considered in detail, the various items entering into it will be enumerated, and the method of reducing the expenditure on it to a standard or unit-value will be explained.

LATTER-DAY DEVELOPMENTS OF THE AMERICAN LOCOMOTIVE.

By H. Keith Trask.

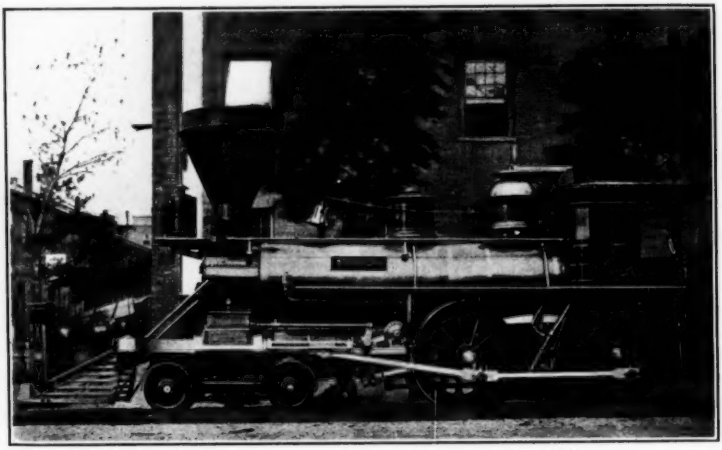
Mr. Trask's review of locomotive development, without sacrificing interest to specialists in locomotive engineering, widens the appeal so as to reach intelligent readers in all branches of the profession and of the engineering industries. By taking up successively the several phases of a development which many have watched with a certain fascination, if not with an exact appreciation of what it meant, he makes the growth of the locomotive appear an orderly evolution, from the little 8-wheeler of the '70's, to the huge articulated Mallet engines, 16 wheeled, compound, with superheater and feed-water heater—veritable locomotive power-plants of 1909. The installment this month takes up wheel arrangements and compounding. Next month's concluding section deals with superheating, feed-water heating, valve motions, and boiler and firebox design. For the illustrations we make cordial acknowledgment to the American Locomotive Co., and the Baldwin Locomotive Works.—THE EDITORS.

TO anyone who will take the trouble to review the history of the development of the American locomotive it must be apparent that the evolution of type has been very marked within the past twenty years. The great strides made in the early days of effort and experiment are known to everyone, but it is not so generally realized that the last two decades have seen, relatively speaking, as great an advance in locomotive design as has any period in the life of the machine to which civilization owes so vast a debt.

In the early days of the locomotive its development was very rapid, but as time went on railways in America settled upon certain standard types of engine for the various classes of service, so that by the beginning of the Reconstruction period in 1865, three types of locomotive were in general use.

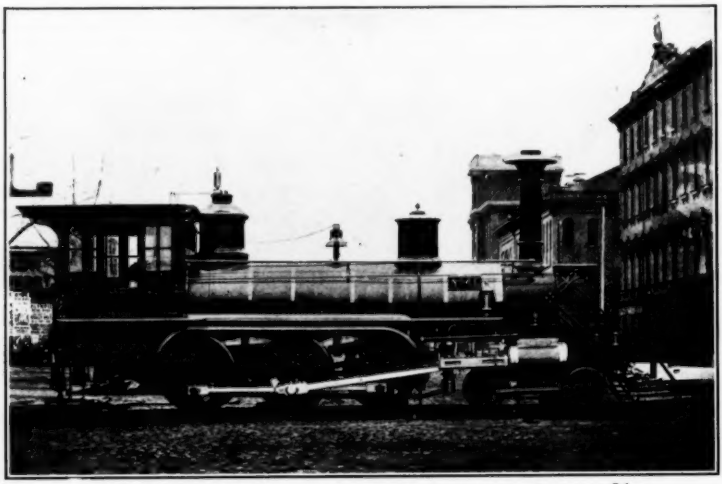
These three types were the eight-wheel, four-coupled American type, which held undisputed sway in passenger service; the six-coupled, eight-wheel type, known as mogul, and the six-coupled type with four-wheel engine truck commonly known as the ten-wheel engine. These latter classes were used chiefly for freight service. Chronologically, the mogul was a development of the ten-wheel engine, due to a desire to place a greater percentage of the total engine weight upon the driving wheels. In 1865 the need of heavier power wherein the individual wheel loads would not exceed the limits of the permanent way, led to the addition of a fourth pair of driving wheels, thus evolving the consolidation type.

For many years from the time of the introduction of the consolidation engine practically no improvement was made in the basic design

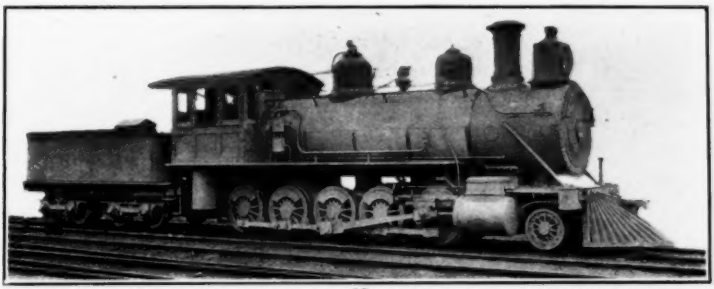


AMERICAN TYPE, LOUISVILLE & FRANKFORT RY., 1864.
Cylinders 15 by 24 in.; drivers 56 in. Baldwin Locomotive Works.

of the locomotive. During these years the size and weight of engines increased to a very marked degree, and the year 1885 saw the birth of the decapod, or ten-wheels-connected arrangement, but even the decapod was simply a consolidation with another pair of driving

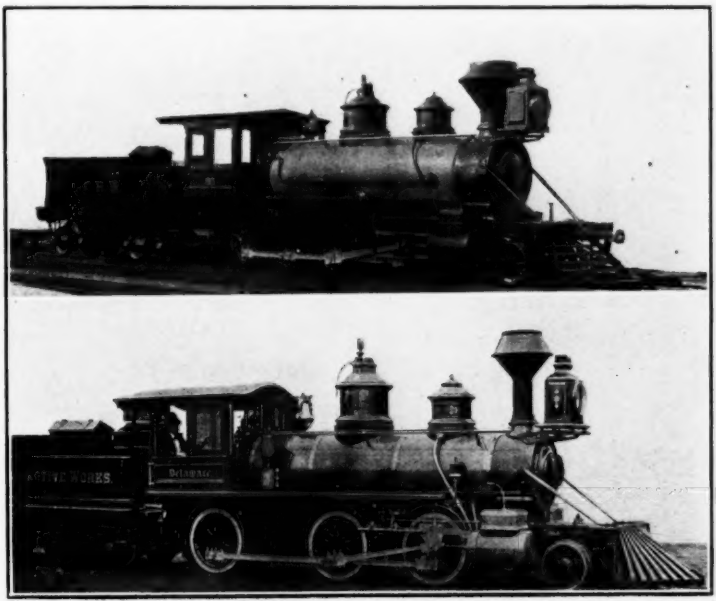


TEN-WHEELED LOCOMOTIVE, NORTHERN CENTRAL RAILWAY, 1862.
Cylinders 18½ by 22 in.; drivers 49 in. diameter. Baldwin Locomotive Works.



NORTHERN PACIFIC DECAPOD OF 1885. BALDWIN LOCOMOTIVE WORKS.

wheels added. Track material and the construction of the permanent way kept pace with the growth of motive power, and the permissible unit wheel loads, therefore, were not exceeded by the standard types of engine. It was not until the introduction of the compound principle in 1889 that the old types were radically departed from, and it was not until 1893 that the then existing wheel arrangements were modified to any extent.



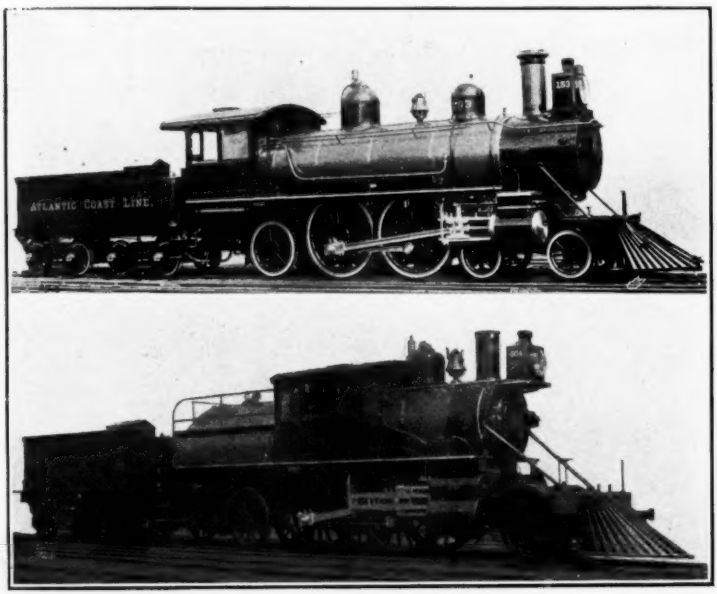
BELOW, A LIGHT MOGUL OF 1876. ABOVE, A CONSOLIDATION BUILT FOR THE FITCHBURG RAILROAD IN 1881.
Baldwin Locomotive Works.

Before 1893, however, the standard wheel arrangements were departed from in one or two isolated instances for some local reason, such as the desire to distribute weight, or to render an engine steadier in running. One case of this nature occurred on the New York, Boston, and Providence Rail Road. The engine in question was a standard American type with short wheel base and heavy boiler. The engine was found too heavy for the permanent way and a small pair of trailing wheels was placed under the fire-box. This was essentially the Atlantic type of engine, but the great point of superiority of the Atlantic engine was overlooked in that the opportunity for the application of a fire-box with greatly increased grate area was not seized. Moreover this arrangement was purely accidental and solitary.

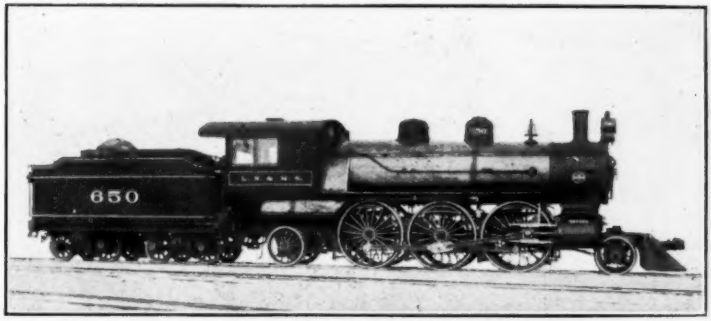
In the consideration of the efforts that have been made in recent years to improve the American locomotive it seems best to treat each phase of its development as an entity rather than chronologically.

Wheel Arrangements.

By 1893 the insistent demands of the public for higher speed created conditions which were met with difficulty by the classes of



ABOVE, AN EARLY "ATLANTIC" TYPE, AND BELOW IT A "COLUMBIA" TYPE OF 1892.
Baldwin Locomotive Works.



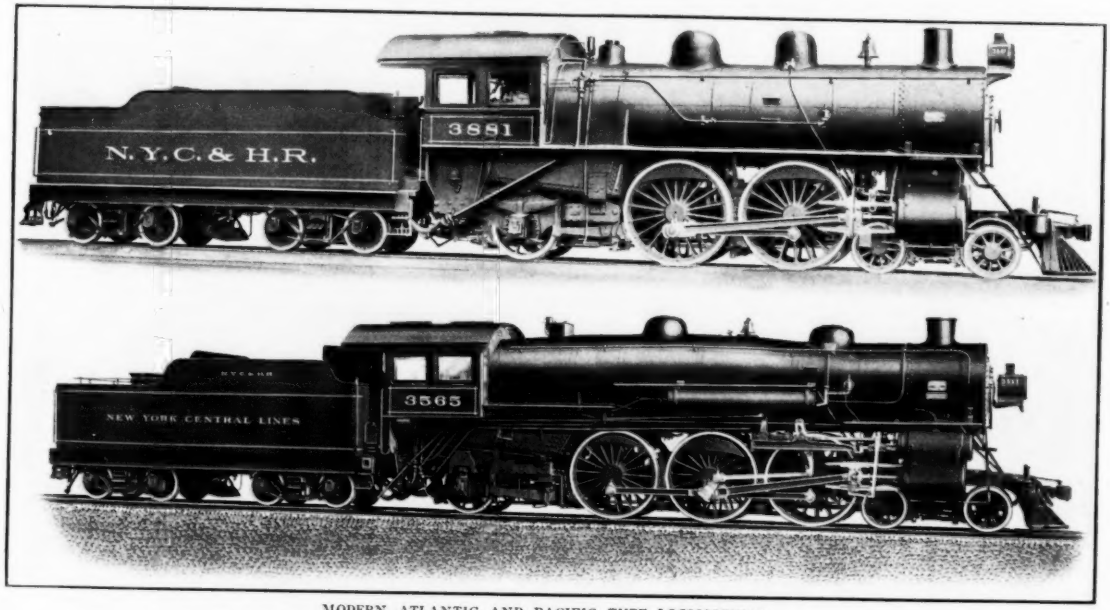
FIRST PRAIRIE TYPE LOCOMOTIVE.
Built at the Brooks works of the American Locomotive Co. Designed by W. H. Marshall, president of the American Locomotive Co., while superintendent of motive power on the L. S. & M. S.

engines then in use. The narrow fire-box necessarily used with large driving wheels placed a limit on the amount of steam that could be generated, since the length of the grate was restricted to the dimensions within which the fuel could be effectively fired. While the Wootten fire-box was used extensively by some roads, the extreme spread of this fire-box and the necessity for keeping the center of gravity low precluded the use of wheels sufficiently large in diameter for sustained high speed.

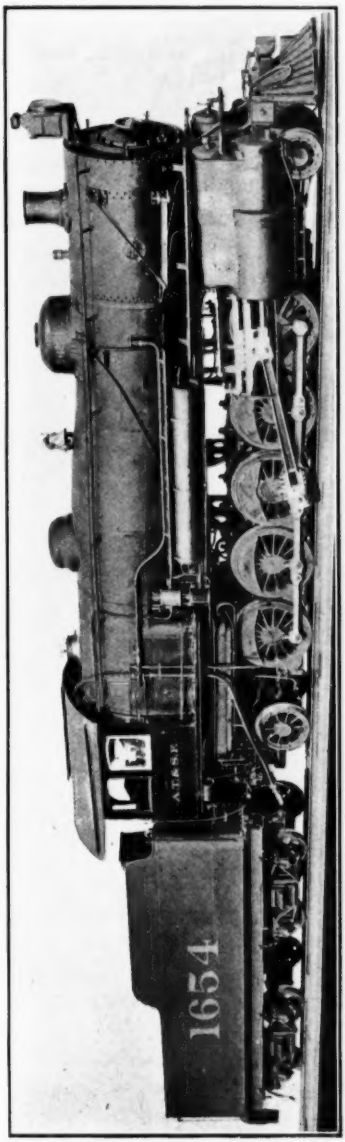
To meet these conditions the Baldwin Locomotive Works brought out an engine with an entirely new wheel arrangement. The four-coupled driving wheels were placed forward of the Wootten fire-box. The weight of the fire-box was carried by a pair of trailing wheels that were equalized with the driving wheels. In the original design a two-wheeled engine truck was provided. This class of engine was known as the Columbia type. In subsequent designs the two-wheeled engine truck was replaced by a four-wheel truck which made the engine more flexible in curving. Thus was evolved the Atlantic-type engine, now so well known.

Shortly after the introduction of the Atlantic-type locomotive the Brooks Locomotive Works brought out a class having six-coupled driving wheels, a pair of trailing wheels, and a two-wheeled engine truck. This design was called Prairie and has been extensively used for freight service.

The demands for passenger power soon exceeded the limitations of the Atlantic-type locomotive and another pair of driving wheels was put under a larger boiler. This combination was at once named the Pacific type. These two types, the Atlantic and the Pacific, are now universally used for heavy passenger trains, and many fine speci-



MODERN ATLANTIC AND PACIFIC TYPE LOCOMOTIVES.
The latest types, built by the American Locomotive Co. for the New York Central lines.



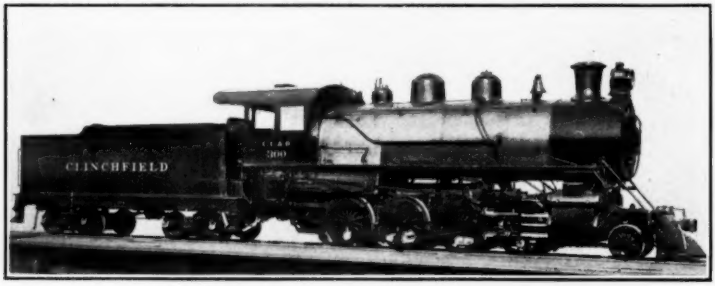
SANTE FE TYPE, TANDEM COMPOUND. BALDWIN LOCOMOTIVE WORKS. THE DECAPOD LACKS THE TRAILERS.

mens, both simple and compound, may be seen on all important American roads today.

The introduction of the Atlantic and the Pacific types of locomotives was caused by the demand for high speed rather than because of any excessive wheel load. The freight engine, therefore, continued to develop in size rather than in form, the consolidation remaining the standard wheel arrangement. The size of these engines gradually increased until the limit seemed to have been reached with a typical engine having 22 inch by 30 inch cylinders and weighing in the neighborhood of 200,000 pounds. This is by far the most generally popular type of freight engine, even today.

About 1892 the Atchison, Topeka, and Santa Fe Rail Road found that for mountain pushing service it required a locomotive heavier than anything yet designed. Two decapod engines with tandem compound cylinders were consequently built and put into service. These engines had cylinders 18 inches and 32 inches diameter by 32 inches stroke, with a weight on the drivers of 237,800 pounds, and a total weight of 267,800 pounds. They were the joint design of S. M. Vauclain of the Baldwin Locomotive Works, and John Player, superintendent of motive power

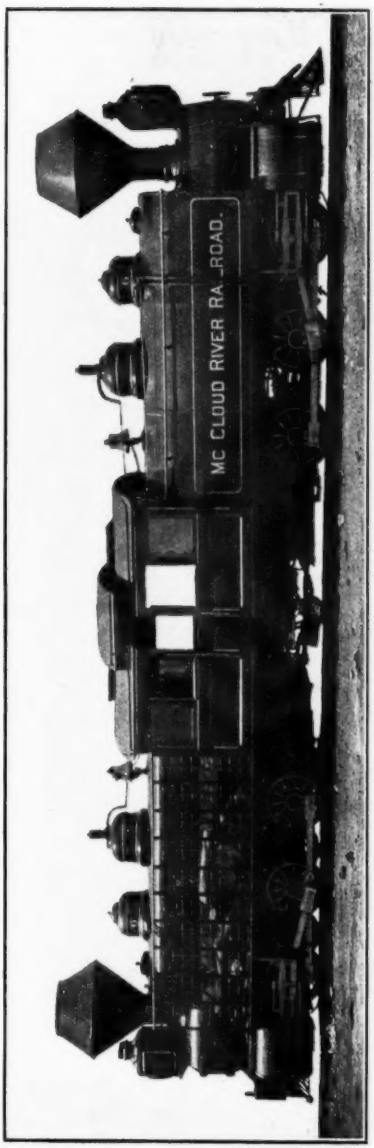
of the Santa Fe Road. The experience gained with these engines on the mountain divisions of the Santa Fe led to the addition of a radial truck under the fire-box to give flexibility and to guide the engine in backing around curves. This design is famous as the Santa Fe type, and is today the heaviest locomotive in the world with rigid frame and rigid driving-wheel base. The design was a complete severance from all then existing standards for freight service.



A MODERN HEAVY CONSOLIDATION, TYPE OF 1909.
Baldwin Locomotive Works.

In 1904 the American Locomotive Company constructed for the Baltimore and Ohio Rail Road a locomotive of a type quite new to American practice, though common in small sizes on the continent of Europe. This was an articulated compound locomotive of the design originally proposed by Anatole Mallet, a French engineer, about 1888.

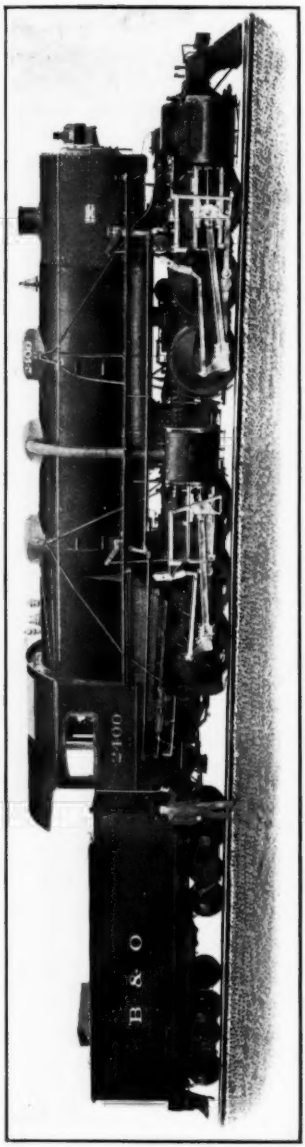
In earlier days American builders had experimented with articulated locomotives of the Fairlie type, without, however, meeting with much success. The Fairlie engine consisted of two boilers with running gear complete, set back to back, and operated from a cab centrally placed over the boiler heads. The frames, upon which were carried the cylinders, were pivoted under the center of the boilers so as to be free to swing radially. Many disadvantages attended this scheme; two of the chief ones being that the high-pressure steam was carried from the boiler to the cylinders through flexible pipes, which it was practically impossible to keep tight, and that there was no method whereby the two engines could be kept working in unison. Slipping gave much trouble, and, when it occurred, it was difficult to stop without grave danger of stalling the train. Another and very serious drawback was the lack of stability. The frames were pivoted at the center of the driving-wheel base and the pushing and pulling of the pistons caused the engines to oscillate or "nose" sideways to a considerable extent.



DOUBLE-ENDER FOR THE MC CLOUD RIVER RAILROAD. A MODIFIED FAIRLIE ENGINE.

To overcome these various disadvantages the Baldwin Locomotive Works modified the Fairlie design by placing two engines of standard type back to back and coupling them together, provision being made to operate both engines simultaneously from a cab placed as in the Fairlie. While this scheme obviated many of the difficulties encountered with the Fairlie the slipping still continued, and but few of these locomotives were ever built. Other modifications of the Fairlie were made, but all these designs were mere sporadic efforts and are of interest chiefly in their bearing on the final adoption of the Mallet articulated compound engine.

As built for the B. & O. the design consisted of a very large boiler mounted upon twelve-coupled wheels arranged in two groups of six wheels each. The rear group of wheels is arranged in the ordinary manner in a pair of frames rigidly attached to the boiler, and driven by a pair of high-pressure cylinders. The forward group of wheels is arranged in a frame which is pivoted to the rear section of the frames, and upon which the boiler is supported by sliding contacts in such a manner



MALLET TYPE LOCOMOTIVE AS BUILT FOR THE B. & O. RAILWAY BY THE AMERICAN LOCOMOTIVE COMPANY.

that the wheels, frames, and low-pressure cylinders are free to move laterally under the boiler, the amount of lateral movement being governed by a spring buffer. The steam pipes from the high- to the low-pressure cylinders and the exhaust pipe from the low-pressure cylinders to the smoke-box are arranged with ball and socket and slip joints to allow the required lateral movement.

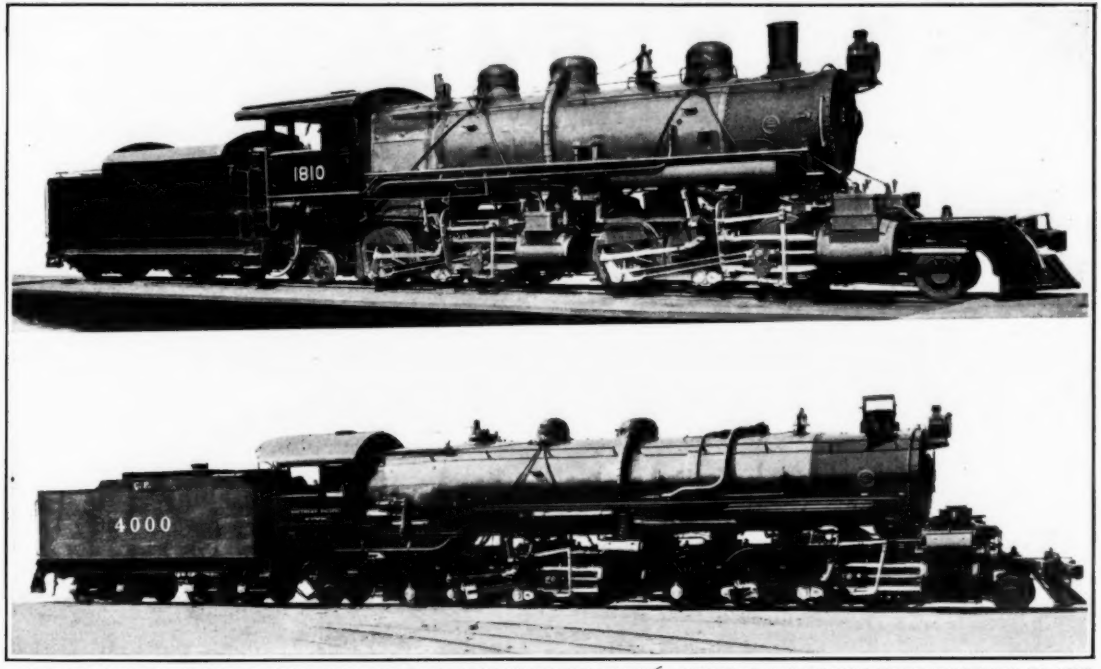
The advantages of this design are manifold. It will be seen that practically the only limits to the size that these machines may attain are those imposed by the gauge and loading limits of the roads for which they are built. None of the difficulties encountered with the Fairlie engine present themselves in the Mallet. The method of attaching the forward swinging frame by pivoting it to the rear rigid frame and carrying the weight of the boiler on heavy slides, having spring buffers to limit side-play, practically eliminates the transverse nosing movement. The Mallet engine is not quite so stable on sharp curves as is the Fairlie. As the boiler of the Fairlie engine rests on center pins its stability is not affected on curves, whereas the Mallet boiler, being rigidly attached to the rear frames, is sometimes thrown dangerously out of balance by the swinging of the forward running gear. Slipping is almost unknown in the Mallet engine. In the event that slipping occurs the engine immediately recovers itself for the two

sections of the engine depend upon each other for the distribution of steam. Should the high-pressure engine slip, the exhaust fills the receiver pipe faster than the low-pressure engine can relieve it. The resultant back pressure on the high-pressure pistons at once restores normal conditions. Should the low-pressure engine slip, the increased steam consumption speedily reduces the receiver pressure to the point where the slipping will cease. The Mallet engine uses one large boiler instead of two small ones. There are no flexible steam pipes conveying high-pressure steam, consequently little opportunity for leakage.

The B. and O. engine marked a departure in basic design. It was a much heavier locomotive than anything previously built, weighing 334,000 pounds, all on the drivers, and was very successful. In 1907 three Mallet engines were built having sixteen coupled wheels and a weight of 409,000 pounds, all on the drivers. These engines are remarkable in that they have Wootten fire-boxes. They were built for pushing service on the Susquehanna division of the Erie.

To James J. Hill of the Great Northern Rail Road, however, is due the credit of developing the real possibilities of the Mallet engine. Mr. Hill believed that by the use of the Mallet engine much of the congestion on the mountain divisions of his road could be eliminated. In conjunction with the motive power officials of the Great Northern, the Baldwin Locomotive Works designed a Mallet engine for mountain work. These engines had to operate on a 2.2 per cent grade with curves of 10 degrees radius. The engines were used to push trains up grade, backing down light, and it was considered doubtful whether machines of such great weight could safely work on such sharp curves and steep gradients. The solution was the addition of a leading and trailing two-wheel truck. This feature proved quite successful, for these engines, weighing 335,000 pounds, 316,000 being on the drivers, are phenomenally easy on wheel flanges and track. It was found by tests with the original engines that this type is suitable not only for slow-speed pushing service, but for road work as well. In consequence a lighter class of 302,000 pounds total weight, with 263,000 on the drivers, is now in service on the Great Northern. These latter engines work on the western divisions of the road over many grades of 1 per cent and easily handle 1,450 tons, cars and lading.

Within the past few months the Baldwin Works has turned out two Mallet engines for the Southern Pacific Co., with sixteen wheels connected and a two-wheel leading and trailing truck. These engines, weighing over 425,000 pounds, are the largest locomotives so far



ABOVE IS A SMALL MALLET ENGINE BUILT FOR THE GREAT NORTHERN IN 1906. BELOW IS ONE OF THE HUGE SOUTHERN PACIFIC MALLETS OF 1909, WITH SUPERHEATER AND FEED-WATER HEATER. BOTH BY THE BALDWIN LOCOMOTIVE WORKS.

built. They have been so recently described in the technical press that it is unnecessary to go into detail here.

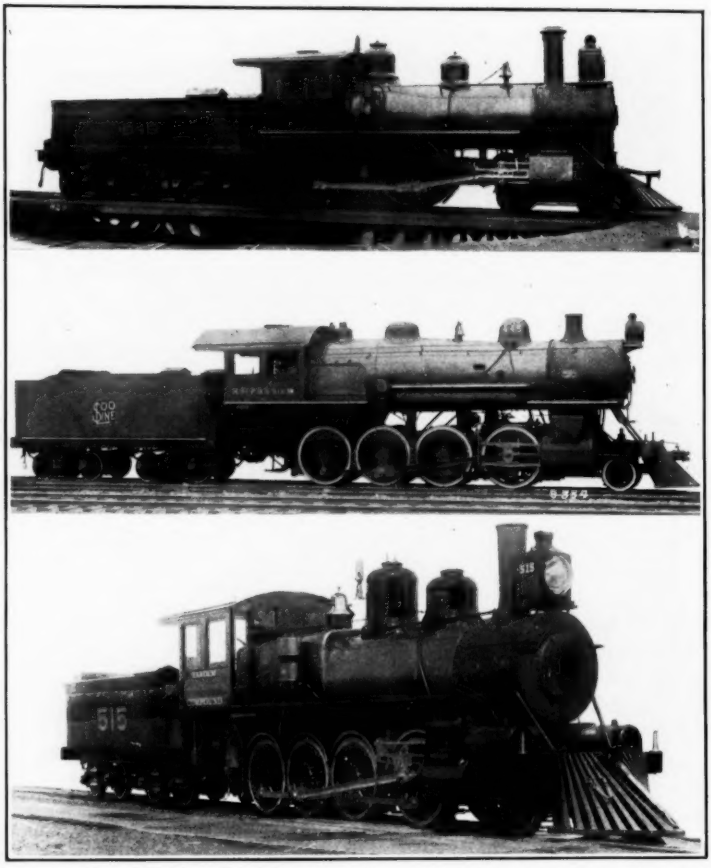
In concluding the discussion of wheel arrangement it is interesting to note that in an assemblage of railroad motive-power officials, in 1899, when the ten-wheel locomotive for passenger service was under consideration, I heard Mr. George S. Strong prophesy that the time was not far distant when we would see passenger trains pulled by the eight-coupled consolidation. Most of those present disagreed with him. Had Mr. Strong ventured a prophecy that within ten years passengers trains would be pulled by engines having sixteen wheels, he would probably have been voted very far out of order. His prophecy as to the consolidation was fulfilled shortly after he made it.

Compound Locomotives.

In discussing the various innovations made in wheel arrangements in recent years reference has frequently been made to the compound locomotive. It has been shown that the demand for greater speed and hauling capacity impelled designers to improve the wheel arrangement of the locomotive and to depart from previously fixed standards, but even before that time the more progressive motive-power men had felt the need of effecting marked economies in the coal and water consumption of a machine notoriously wasteful in operation.

In marine practice multiple expansion has been universally employed for many years. On the continent of Europe designers had early turned their attention to the employment of this principle in the locomotive, and many designs had been tried, some with most gratifying results. Compounding therefore seemed the logical direction in which to look for improved economy in operation.

In 1889 S. M. Vauclain of the Baldwin Locomotive Works designed a compound locomotive, the first example of which was built for the Baltimore and Ohio Rail Road. Mr. Vauclain's patents were for a four-cylinder compound locomotive in which the axes of the high- and the low-pressure cylinders on each side of the engine lay parallel in the same vertical plane. One hollow piston valve controlled the distribution of steam to each pair of cylinders, and the valve motion for actuating the valves was the same as in a simple engine. The two pistons of each set of cylinders were coupled to a single crosshead. The original engine was an American type, but after the introduction of the Atlantic engine this system of compounding was extensively used with that type. It was also applied to many engines of other types, but, due chiefly to inherent disadvantages of



AT THE TOP IS THE FIRST BALDWIN VAUCLAIN COMPOUND. NEXT IS A SCHENECTADY TWO-CYLINDER COMPOUND, AND BELOW IT THE ORIGINAL BROOKS TANDEM COMPOUND, ALSO SHOWN BY COURTESY OF THE AMERICAN LOCOMOTIVE COMPANY.

design which made maintenance costly, thereby offsetting the economy in fuel, the popularity of this style of compound has gradually waned.

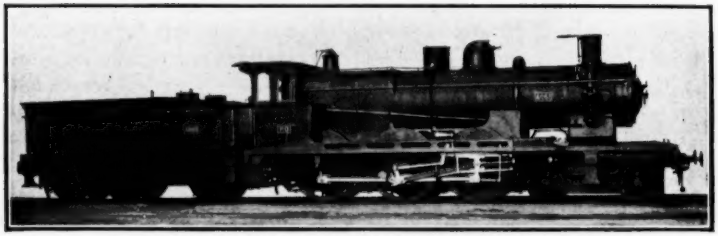
At about the same period that the Baldwin four-cylinder compound was introduced, the Rhode Island Works brought out a two-cylinder design. This was followed almost immediately by two-cylinder compounds from all other manufacturers. The two-cylinder compounds were all of the same general type. The high-pressure cylinder exhausted into a receiver placed in the smoke-box, whence the steam passed to the low-pressure cylinder, and so to the at-

mosphere. The difference in design lay in the intercepting valve. In the two-cylinder compound it was necessary, in starting the locomotive, to use boiler-pressure steam in the low-pressure cylinder until such time as the exhaust from the high-pressure side had passed into the receiver, and thence to the low-pressure cylinder, when the boiler pressure would be shut off. Various devices were used to accomplish this end. In some cases the operation was performed manually, in others the change from simple to compound was effected by the operation of "hooking up" the reverse lever, while in other cases the intercepting valve functioned automatically by the variations of receiver pressure. One serious defect the two-cylinder designs all had in common. The unequal power exerted on the two sides of the engine resulted in very serious nosing, which made the engines hard riding, racked the machinery, and did not improve the track.

Shortly after the introduction of their two-cylinder compound the Brooks Works brought out a four-cylinder compound in which the high- and low-pressure cylinders on each side were placed tandem, the low-pressure cylinder ahead, and with their axes concentric. Separate valves were employed for each cylinder, the two valves on each side being driven from the same valve rod with a rocker interposed in the steam receiver to reverse the motion of the high-pressure valve. This was rendered necessary by the fact that both cylinders took steam on the same end simultaneously and an internal-admission piston valve was employed for the high-pressure cylinder, and either an external-admission piston valve or a balanced slide valve for the low-pressure cylinders. The low-pressure cylinders and valve chests were integral with the cylinder saddle, while the high-pressure cylinders and valve chests were in a separate casting. One piston rod coupled to its crosshead served for each pair of high- and low-pressure pistons.

In its original form the tandem-compound locomotive was not a success. The rocker arm in the receiver was a continual source of annoyance, and the packing between the high- and low-pressure cylinders was difficult to maintain. After the formation of the American Locomotive Company the rocker arm was eliminated, crossed steam ports for the high-pressure cylinder being substituted, and the design of the packing between the cylinders was materially altered. With these changes the tandem-compound design proved more acceptable.

At the time that the Santa Fe engines, previously referred to, were designed it was considered desirable by the railroad company to adopt the tandem-compound principle. Accordingly the Baldwin Works developed a tandem compound essentially different in details



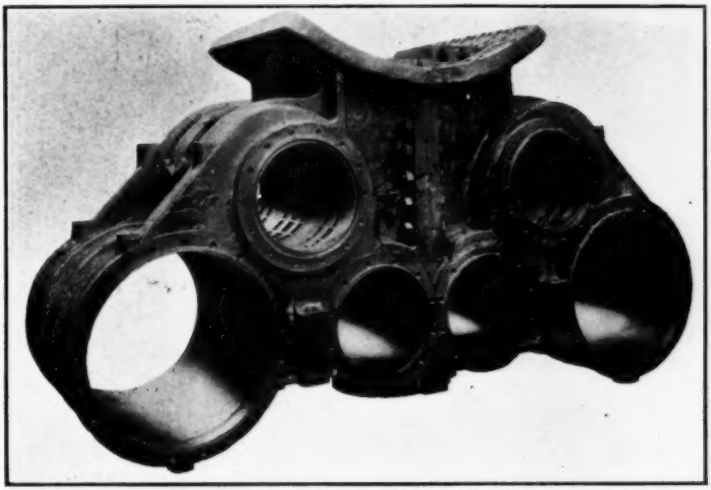
DE GLEHN COMPOUND FOR PARIS-ORLEANS RAILWAY, 1907.
American "Pacific" class; Baldwin Locomotive Works.

from that built by the American Locomotive Company, although identical in principle. Crossed steam ports in the high-pressure cylinders were avoided by the use of a double hollow piston valve wherein the exhaust steam from the high-pressure cylinder passed through a central port, thence through the hollow valve body to the low-pressure valve chest. Each cylinder and valve chest formed a unit, the saddle being a separate casting. A number of the Santa Fe engines were built, but neither the type nor the tandem-compound principle have been generally adopted throughout the country.

The chief argument against the earlier types of compound was, as has been said, the increased cost of maintenance, which in many cases overbalanced the saving in fuel. This saving was, however, marked and in consequence railroad officials were loath to abandon an improvement presenting so many advantages. It was early decided that the two-cylinder compound was not desirable, but the four-cylinder type, either tandem or Vauclain, presented so many advantages that determined efforts were made to improve this type. These efforts were further stimulated by the destructive effects of the hammer blow inflicted on the track by heavy engines at high speed, due to inability of designers properly to balance the massive rotative parts of the modern locomotive.

In Europe a four-cylinder balanced compound, the design of MM. de Glehn and du Bosquet, has been successfully employed for many years. In this engine the cylinders are so placed as to divide the application of power between two driving axles. The high-pressure cylinders lie outside the frames, and are usually connected to the second pair of driving wheels. They are placed some distance back of the saddle in order to equalize the length of the connecting rods. This arrangement is the more convenient since plate frames are universally employed for these engines. The low-pressure cylinders are located in the cylinder saddle between the frames and drive upon the forward pair of driving wheels by means of a cranked axle. The high- and low-pressure crank on the same side

of the engine are set at an angle of 180 degrees, while the two high-pressure and the two low-pressure cranks are set at an angle of 90 degrees to each other. This arrangement permits of perfect balance of the rotative parts. Separate valve motions are employed for the high- and low-pressure cylinders with slide valves for each cylinder, and an arrangement of the reverse gear whereby the cut-off may be varied separately for the high or low pressure. The steam is conveyed from the high- to the low-pressure cylinders through a valve in the form of a sleeve having suitable ports cut in it. This valve is rotated on its axis by air pressure from the cab, and by its position determines whether the engine will operate simple or compound.



CYLINDERS FOR BALANCED COMPOUND LOCOMOTIVE.
Baldwin Locomotive Works.

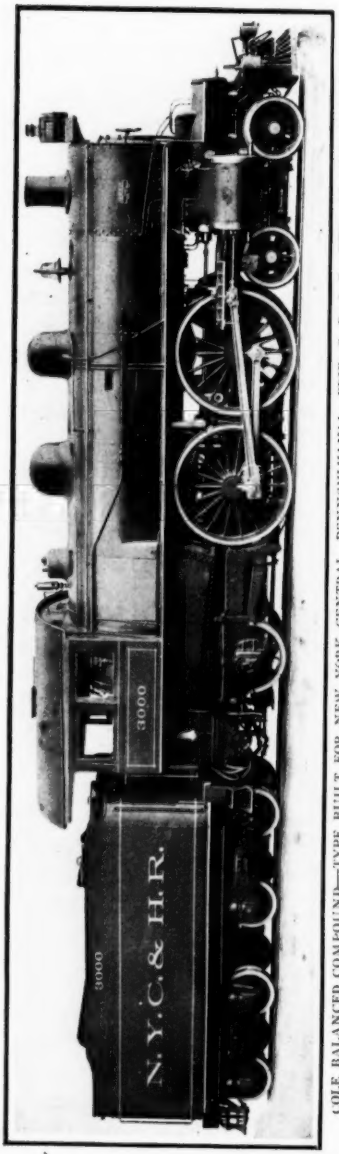
It was recognized that while the de Glehn engine was too complicated ever to meet with much favor on American roads, a simplification of this engine was what was required. Accordingly early in 1902 the Baldwin Locomotive Works brought out a balanced compound design that differed materially in detail from the de Glehn while retaining all the successful features of that design.

The Baldwin design comprised an engine in which the four cylinders lie abreast, with their axes in the same horizontal plane. The high- and low-pressure cylinders for each side of the engine with their appropriate valve chest, are contained in a half-saddle unit, precisely as in a simple engine. By a reversal of the de Glehn arrange-

BALDWIN BALANCED COMPOUNDS OF REGULAR TYPE, AS BUILT FOR NEW YORK CENTRAL, PENNSYLVANIA AND OTHER LINES.

BIFURCATED CONNECTING ROD SOMETIMES USED WITH BALDWIN BALANCED COMPOUNDS.

ment the low-pressure cylinders are outside the frames and the high-pressure cylinders between them. A single piston valve of the same type as in the older Vauclain compound controls the distribution of steam to each pair of cylinders, and these valves are driven by the same mechanism as is employed for a simple engine. As in other designs, a starting valve is provided to admit boiler pressure to the low-pressure cylinders. Each piston is coupled to a separate crosshead. The high-pressure pistons usually drive a cranked axle on the leading pair of drivers, while the low-pressure pistons are coupled to crank pins in the usual manner, and may drive on whatever pair of wheels is found most convenient. In some Prairie and Pacific type engines where the front drivers are very close to the cyl-



COLE BALANCED COMPOUND—TYPE BUILT FOR NEW YORK CENTRAL, PENNSYLVANIA, ERIE, C. B. & Q., ETC., BY THE AMERICAN LOCOMOTIVE COMPANY.

inder saddle it has been found necessary in order to get the proper length of main rod to make the second or intermediate axle the crank axle. In these cases one of two expedients has been resorted to. Either the high-pressure cylinders have been set at an incline with their axes sufficiently above the center line of the wheels for the connecting rods to clear the forward axle in their lowest position, or else the cylinders have been placed in their normal position and the forward axle spanned by a bifurcated connecting rod.

At about the same time that the Baldwin balanced compound appeared the American Locomotive Company introduced a balanced compound engine from the design of F. J. Cole. This engine differed from the Baldwin in that the high-pressure cylinders are carried on an extension of the engine frames ahead of the cylinder saddle, the back head of the high-pressure cylinder being in the same plane as the front head of the low. A combination valve and a single set of valve motion is employed for each set of cylinders.

Both these types of balanced compound are in successful operation, and may be said to have solved the problem of sustained high speed with heavy trains.

EFFICIENCY IN THE PURCHASE OF FUEL FOR POWER GENERATION.

By Walter N. Polakov.

"It is the task of the combustion engineer to devise an apparatus which will utilize the largest percentage of the heat units in the fuel; but the more difficult problem of the economic engineer is to select the fuel and burn it so as to secure the desired result at the lowest price."—HARRINGTON EMERSON, "Efficiency as a Basis for Operation."

ACCORDING to a Chinese custom, the groom pays for his bride in proportion to her weight. An equally senseless method of buying coal still prevails in the Western World. Weight rather than available energy is alone considered.

While recent advances in theoretical thermodynamics have opened new opportunities for progress, men of affairs have continued to dissipate energy. They have transformed it in wasteful fashion, till finally the cry of alarm is heard: "Let us conserve the foundations of our prosperity!" Of these foundations the sources of energy are the corner-stones. Our chief interest at present is to define what degree of efficiency is practically attainable in the purchase and utilization of fuel for steam generation. It is perfectly clear that the problem before the efficiency engineer is that of showing how to make the actual processes approximate the ideal reversible processes. The degree of such approximation, expressed in percentage and reduced to a unit of time, we call "efficiency." This efficiency, therefore, must be determined for each step of the process by which energy in one form is transformed into energy in another form. Granting that the actual can thus be compared with the ideal, and knowing how to define the degree of efficiency discovered, we are no longer in the disadvantageous condition of attacking an enemy whose position and force are unknown.

Efficiency engineering furnishes scientific means for determining with precision the measure of waste and of preventable losses in productive processes. These wastes and losses are large in the ordinary process of power generation. In this process we have to consider primarily three stages:

1. The purchase of fuel, including receiving, storing, and handling; this is the transformation of money into potential thermo-chemical energy.

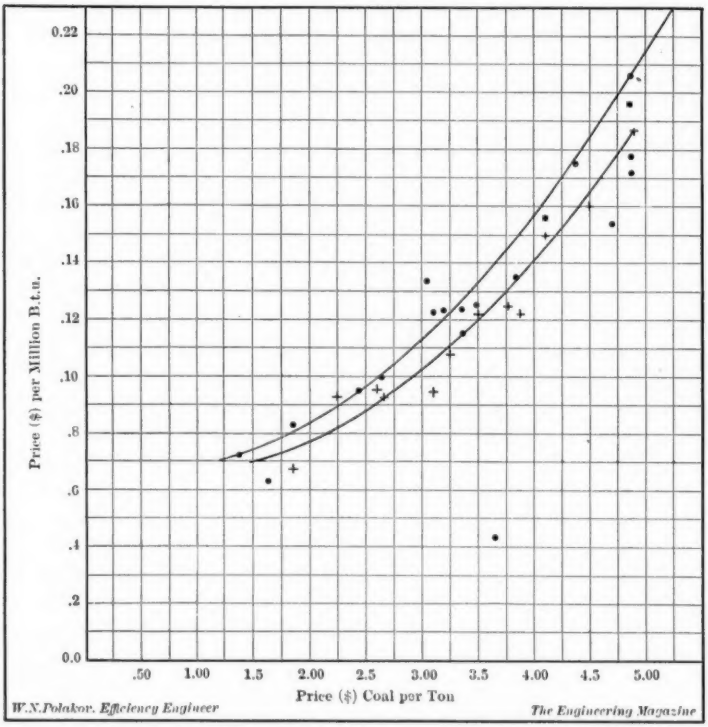


FIG. I. APPROXIMATE COSTS OF 1,000,000 B.T.U. IN VARIOUS COALS.

2. The combustion of the fuel under the boilers; this is the transformation of potential thermo-chemical energy into heat energy of the gases in the furnace.

3. The utilization of the heat generated in the furnace for the evaporation of water in the boiler; this is the transformation of the heat of the furnace gases into the volume energy of steam.

The first of these stages—the purchase of fuel—is usually characterized by great inefficiency. It is true that it may be profitable to make use of a process of low efficiency if the unit cost of the resultant output is small. The efficiency of a beam engine is much lower than that of a triple-expansion condensing engine, but sometimes the use of the former is commercially more economical. Analogous conditions may be observed in burning fuels of varying grades and prices in different types of furnace.

The curves in Figure 1 show approximately the cost of a heat unit from various grades of coal on the market. The prices at which some

of these kinds of coal are sold are not proportionate to their thermo-chemical value. In other words, though in the cheaper kinds of coal there are fewer B. t. u. to the pound, yet one cent expended for such coals buys more heat. The possible commercial advantage from the use of these cheaper and poorer grades of fuel (screenings, breeze, culm) is, however, diminished by the increased cost of maintenance and the more rapid depreciation of the apparatus which is necessary to enable us to utilize the maximum heat units obtainable from this fuel. It is therefore sometimes more profitable to use fuels intrinsically more expensive, which yet can be fully utilized without additional expense for apparatus. Finally, cases are never met with in practice where the resultant efficiency could not be increased by a more complete utilization of the fuel in the furnace, though there are many cases where this source of potential saving is negligible in comparison with the large economy obtainable by changing the coal specifications.

It must be kept clearly in mind that the primary stages of the transformation of energy from one form to another stand to each other not on a simple co-relation, but in dependent sequence; the earlier the stage, the larger will be the influence of any increase in its efficiency. Let us take a pumping plant as an example. The specific purpose—the end we have in view—is the lifting of a certain amount of water to a given height. To secure this final result, however, fuel, equipment, supplies, labor, and methods are used, not directly, but in successive steps from one intermediate stage to another. The primary stages (leaving minor operations out of consideration) are tabulated below, the nature of the change involved in each being shown in the second column, and the normal efficiency likely to be realized in practice being assigned to each in the third column.

Name of step.	Transformation of Units.	Efficiency.
Purchasing of coal.	Dollars into pounds of coal...	67.77
Combustion of coal on grates.	Pounds of coal into B. t. u...	90.10
Utilization of heat for generating steam.	B. t. u. into pounds of steam..	86.28
Utilization of steam in the engine, (including the efficiency of the steam piping).	Pounds of steam into horse power	82.20
Utilization of mechanical energy of the engine for pumping.	Horse power into foot pounds (duty)	89.11
Resultant total efficiency.	Dollars into foot pounds—foot pounds into dollars....	37.06

The point to be emphasized is one that should be self-evident—that the resultant efficiency is only 37.06, because the loss in each step decreases the residual efficiency remaining after the preceding loss, or, in other words, each process deals only with that part of the

original energy still remaining unwasted. This simple fact, however, is too often overlooked, and the resultant efficiency in such an example as this is erroneously determined by the method of arithmetical mean to be as high as 83.13. This mistaken method of calculation recalls the many-centuries-old tale of a wealthy Kirgizian, who thought to distribute his herd equally among all his sons by providing in his will that the eldest son should give half the sheep to the second, the second should give half of what he received to the third, and so on.

For our purpose, that is, the determination of the efficiency of coal purchased, the first three steps tabulated above must be examined; that is, we must find first the "efficiency of payment"—whether the price is reasonable and how reasonable; for this efficiency we may use the symbol E_m. Second, "efficiency of combustion"—whether all the available combustible in the given fuel is decomposed; for this we may use the symbol E_t. Third, "efficiency of heat utilization"—whether the gases are thoroughly consumed and whether they deliver all their heat, or whether some of them are incompletely burned or are carrying away heat which might be utilized under attainable conditions; for this we may use the symbol $E\phi$. These financial, technical and thermo-chemical factors of the total resultant efficiency of the fuel (E_r), converted into decimals, can be expressed in a formula which is universal for all kinds of fuel under all conditions:

$$E_r = E_m \times E_t \times E\phi$$

In each of the three primary stages we have just been considering we can differentiate minor or secondary stages, standing to one another sometimes in the relation of dependent sequence, sometimes in simple co-relation; these should be analyzed in conjunction with their corresponding primary stages. Thus, both theroetically and practically, nine typical variations are possible in the underlying conditions that affect the resultant commercial efficiency of the fuel—that make it possible to increase this efficiency by proper selection, purchase and utilization of fuel.

In recent years we have often heard the statement "coal should be bought on a basis of the results it will give; that is, on the basis of thermal units."*

This statement is true only as to the first part; the purchase of coal, like any other purchase, should be based on teleological grounds; but the result to be considered depends not only upon the number of thermal units the coal will yield, but also upon the adaptability of the fuel, chemically and physically, to the furnace in which it is to be burned. It is well-known that certain coals are especially suited for

* *American Machinist*, the *Engineering Digest*, September, 1908.

certain purposes, and it is not necessarily true that the coal highest in B. t. u. will be the best for our special purpose, even though it be completely burned. For instance, coals high in volatile matter are the most difficult to burn efficiently, although they are high in B. t. u. Furthermore, coals of nearly the same percentage of volatile matter have different heating powers on account of the presence of heavy hydro-carbons and tar, or volatiles which are not combustible at all.*

In the estimation of total or resultant efficiency the efficiency of each step must be determined. Generally speaking, there are two methods of determining efficiency; one, theoretically unassailable, is the expression in percentage of the ratio between energy actually utilized and energy available; the second is that successfully used and fully described by Harrington Emerson—the comparison of actual results with a certain standard whose fixed points are chosen arbitrarily, like the sea-level for the comparison of heights or railroad profiles, or like the freezing and boiling points on a thermometer scale. This latter arbitrary method of standardization should be used in calculating the efficiency of the first step in our process of fuel combustion. We must establish a certain standard cost per unit of thermo-chemical energy stored in the fuel. And for the purpose of comparing the efficiency of the plant regardless of its location, this location also must be expressed by a certain factor.

It is not necessary here to go deeply into the peculiar art of establishing standards. For illustration only, let us assume that 1,000,000 B. t. u. in steaming coal could be bought for 5 cents, while the actual prices paid for two kinds of steam coal used by a certain plant are 6 cents for 1,000,000 B. t. u. in small-sized anthracite, and 8 cents for the same potential thermal energy in bituminous coal; then the financial efficiency in these two instances will be 83.3 per cent and 62.5 per cent respectively.

Our second step will be to determine the efficiency of combustion of the coal we are considering. In other words, we must apply exact methods of calculation to determine the ratio of energy utilized to energy available, this being the ratio to which we have given the title "efficiency of combustion." Let us assume again that under the conditions of our special case the coal purchasable at 6 cents per 1,000,000 B. t. u. can not be completely burned, but leaves on the grates and in the ash pit 38 per cent of unconsumed refuse. This coal, let us assume, shows by analysis 18 per cent of ash. The 38 pounds of unconsumed refuse, therefore, which is left by each 100 pounds of coal, contains but 18 pounds of absolutely non-combustible ash, the

* Reports of U. S. Geological Survey.

remaining 20 pounds (or 52.6 per cent of the entire refuse left) being combustible, although left unconsumed. The efficiency of this process can be easily computed. 100 pounds of dry coal consists of 18 pounds ash and 82 pounds combustible, out of which 82 pounds we are wasting, as we have already seen, 20 pounds. The remainder, 62 pounds, is therefore the quantity of combustible utilized. The efficiency, therefore, will be:

$$\frac{\text{Combustible used}}{\text{Combustible available}} = \frac{62}{82} = .756$$

In other words, the efficiency of our process of combustion is 75.6 per cent in the case of the coal costing 6 cents for 1,000,000 B. t. u. Figures 2 and 3 show in graphical form the relation between the combustion of coals, the percentage of refuse to coal used, the percentage of combustible in the refuse, and the efficiency of coal consumption.

Let us now assume further that the bituminous coal already referred to costing 8 cents per 1,000,000 B. t. u. shows an efficiency of combustion as high as 96.6 per cent under the same conditions as the anthracite just considered. And let us assume that the efficiency of the third stage (the utilization of the products of combustion, or, in other words, the transformation of the heat energy of the gases into volume energy of steam) is 64.1 per cent in the case of the anthracite and 71.2 per cent in the case of the bituminous coal. The efficiency of this third stage is determined by actual steaming or evaporative test, and is figured in accordance with the formula for conducting boiler trials given in the code of the American Society of M. E.

$$E = \frac{\text{Heat absorbed per pound of combustible}}{\text{Thermal value of one pound of combustible}}$$

We have now all the data necessary for determining which coal is the more efficient. A comparison of the resultant efficiencies of the two kinds of coal shows:

Anthracite; total efficiency $= (83.3 \times 75.6 \times 64.1) \div 10{,}000 = 40.367$
Bituminous; total efficiency $= (62.5 \times 96.6 \times 71.2) \div 10{,}000 = 42.987$

We can see at a glance that the use of the coal costing most per ton and per unit is in this particular case about 6 per cent more economical than the use of the other coal which, judged by price per ton alone, appears to be 25 per cent cheaper. The difference in the efficiency figures of our two samples is due to the high percentage of volatile matter in the bituminous coal, which can not be utilized in the furnace under consideration.

Let us now assume that we install a mechanical device for the better utilization of coal No. 1 (anthracite screenings) which will cut

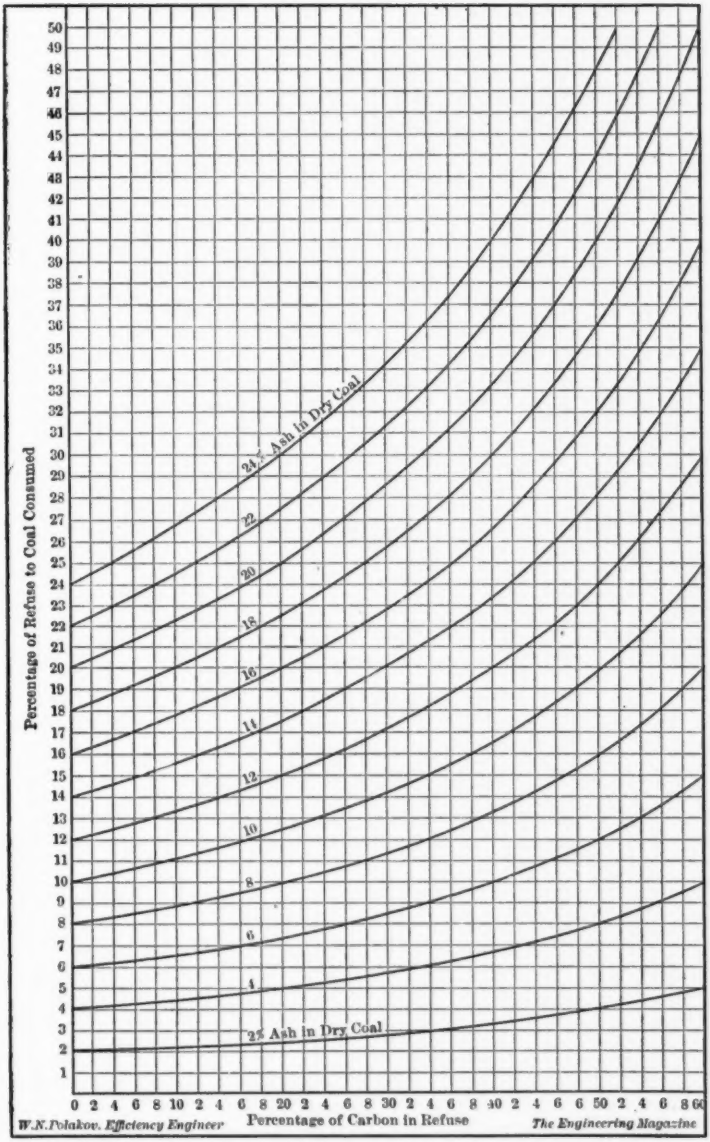


FIG. 2. CHART SHOWING GRAPHICALLY THE RELATION OF CARBON IN REFUSE TO TOTAL CARBON CONSUMED.

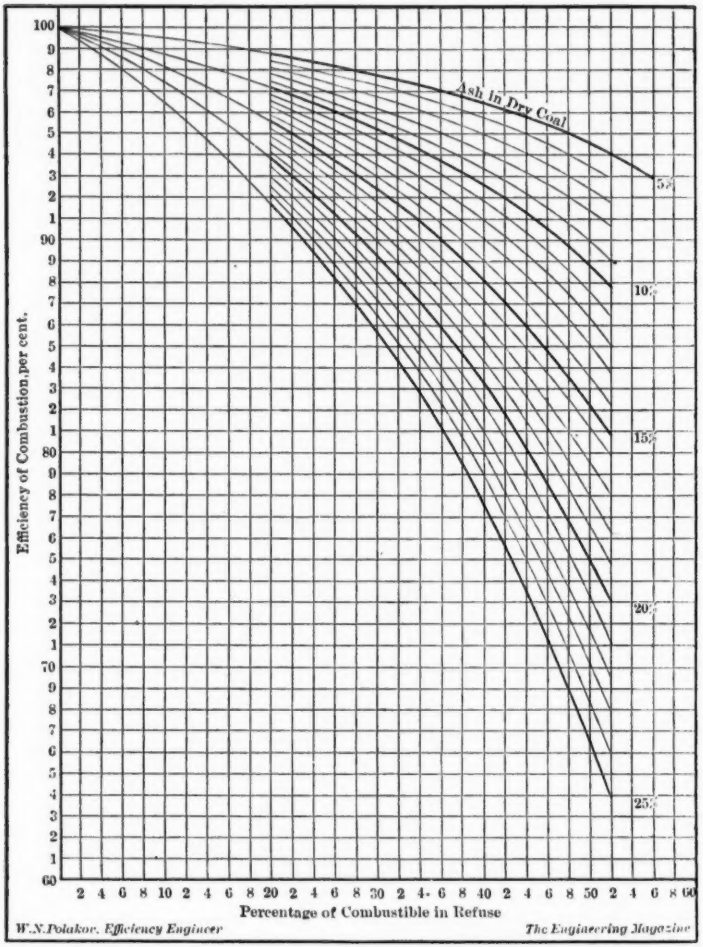


FIG. 3. SHOWING THE RELATION OF CARBON IN REFUSE TO EFFICIENCY OF COMBUSTION.

down the amount of unburned combustible in the ash to 34 per cent instead of our preceding 38 per cent; the efficiency of our second step (efficiency of combustion) will thus be raised to about 86 per cent (instead of the preceding 75.6), and because of the better draft the efficiency of the third stage (heat utilization) will also rise and reach 70 per cent (instead of 64.1). The total or resultant efficiency will then become 50.15 instead of 40.3 as before, and the anthracite

screenings will prove about 17 per cent more economical than bituminous. Our task is next to determine whether the gross saving after providing for interest on investment, depreciation, maintenance, and labor will leave a net saving sufficient to warrant the installation necessary to burn the anthracite screenings.

To determine these efficiencies certain points which have not yet been discussed should be carefully noted. It is self-evident that in determining the cost of 1,000,000 B. t. u., the cost of additional freight, handling, removal of ashes, etc., must be taken into account and must be determined on the basis of the average percentage of ashes in the coal we are considering. In some cases, however, out of several lots of coal received under the same contract, certain deliveries may show a percentage of ash higher than the average and yet prove higher also in B. t. u. This fact is shown by the following analyses:

Anthracite Pea.	Case A.	Case B.
Moisture	2.6	3.8
Ash	28.7	18.3
Volatile matter	4.2	5.2
Fixed carbon	64.5	72.7
B. t. u. commercial	10,792	10,748
B. t. u. No. 1 pound dry	11,080	11,173

It is the province of the analytical chemist to determine whether the loss of thermal value in Case B is due to endothermic reactions caused by certain constituents in the ash, or by some other cause. The example, however, is not an exceptional one and it serves to illustrate the small value of proximate analyses or of the simple determination of "slate and bone" without a calorimetric test. On the other hand, the percentage of ash shown by analysis can not at all be taken as a safe guide in estimating the cost of handling, since the percentage of refuse actually left unburned may be entirely out of proportion to the figures of ash as disclosed by analysis. In our comparison of two coals costing $1.65 and $2.53 per ton respectively, the cost of handling refuse at 26 cents per ton occasions a surcharge of 9.88 cents and 2.6 cents respectively, although the percentage of ashes appears by analysis to be 7 and 18. The practice followed by some companies of basing their figuring on the percentage of ash shown by analysis, instead of on the average of ashes actually produced, is therefore bad. The second point which should always be kept in mind is the wide range of actual heating power apparently exhibited by the volatile matter, if we consider the heating value of fixed carbon as a constant and consider the ashes to be inert. A high percentage of volatile matter, therefore, does not necessarily mean an increase in the resultant heating value of a coal. The number of B. t. u. in one pound

of volatile matter in coal, as shown by actual burning of the coal in a bomb calorimeter, appears to vary from 44,000 B. t. u. down to a negative value. It is apparent that the heating value of the volatile combustible, very high in the case of high percentages of H and CH_4 for instance, can not descend below zero even if the volatile matter were composed of absolutely incombustible gases as CO_2, O and the like. Nevertheless, two samples of different coals repeatedly analyzed by different chemists give the following results:

Kind of Coal.	Semi-bituminous	Anthracite
Size	Run of mine	Pea
Moisture	1.5	3.9
Ash	7.2	15.0
Volatile matter	15.7	4.6
Fixed carbon	75.6	76.5
B. t. u. commercial	14,293	10,792
B. t. u. dry	14,510	11,230

In sample No. 1 the heating value of one pound of the fixed and volatile combustible free from ash and moisture would be 14,293 ÷ (.756 + .157) = 15,655 B. t. u. The percentage composition of the combustible considered by itself is 17.2 per cent of volatile matter and 82.8 fixed carbon. As the heating value of carbon is 14,544 B. t. u. per pound, the 82.8 per cent of fixed carbon would account for 12039.73 B. t. u. Therefore, the 17.2 per cent of volatile appears to be credited with 15,655—12,039.73 B. t. u. = 3615.27 B. t. u. This is equivalent to a thermal value of 21,019 B. t. u. per pound.

In sample No. 2 the heating value of one pound of combustible free from ash and moisture would be 10,792 ÷ (.765 + .46) = 13,307 B. t. u. The percentage composition of a pound of combustible in this coal taken by itself would be 5.67 per cent of volatile matter and 94.33 per cent of fixed carbon. Taking again the constant heating value of carbon at 14,544 B. t. u. per pound, the fixed carbon in this second sample alone would give 13,179 B. t. u., which is 412 B. t. u. greater than the heating value of a pound of the combustible with the volatile matter included. In other words, our 5.56 of volatile matter appears to have a minus thermal value of 412 B. t. u., or a minus thermal value of 7,266 B. t. u. per pound of volatile. At all events, a quantity of heat equivalent to this has somehow disappeared in the combustion of the coal.

It is necessary to determine carefully to what degree of efficiency the respective kind and size of coal can be burned on the grates and under the conditions with which the plant must operate. High percentages of combustible in the ashes are often due to unsuitability in the design of the grate, the force of draft used, the size of coal fired,

etc., and each individual case, therefore, should be examined separately. To determine in any particular instance whether it would be more economical to change the coal or to alter the furnace is a rather complicated problem, because the personal factor, which is of great importance, must be carefully and minutely examined and its influence computed. There are many dangerous theories on the subject of the best combustion of the gases liberated from coal, and the utilization of the largest possible proportion of their heat. To these may be referred the strenuous effort of many engineers for high carbonic acid in the flue gases, and the belief that the lower the velocity of the gases the better is the absorption by the heating surface. When carbonic acid is recorded the use of a recording draft gauge is absolutely essential. High carbonic acid with large percentages of carbonic oxide and free hydrogen is very much worse than low carbonic acid. Exact knowledge of the composition of the coal is imperative. Steadiness of draft indicates an even fire and therefore is important. The great value of a very strong draft—far above the usual limit—is proved by the notable tests made by Nicholson. These and a thousand other possibilities of reducing waste belong distinctly to the province of the efficiency engineer.

To sum up the preceding discussion: In considering the alternatives of changing the grade of fuel to suit the furnace, or changing the furnaces and introducing apparatus to suit the coal, many boiler trials must be run, and the rules defining standard practice in firing and the care of both boilers and fuel must be published in the power-plant with each change of fuel or machinery. The maintenance of the resultant efficiency as near as possible to the highest attainable standard is another problem for the efficiency engineer.

Designers of steam boilers exert every effort to secure high efficiency, and steam engineers extend the search for conditions and methods that will insure complete combustion, but thus far little has been done to improve on the old methods of buying fuel. In the purchase of water for drinking we demand volume and purity; in the purchase of water for power we require hydraulic head; in the scientific choice of food we take into consideration its calorific and sustaining qualities; in contracting for steel we submit definite specifications as to tensile strength, chemical composition, and microscopic structure; in buying coal we accept the dealer's bare statement that it burns well, and we pay for its weight instead of thermo-chemical energy. Such crude practice should find no place in a civilized country, and its present frequency clearly shows the great confusion of ideas and colossal inefficiency reigning in the field of the purchase of fuel.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's first two articles in this series, published in September and October, were based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use that the series has been completed, at the invitation of THE ENGINEERING MAGAZINE, for wider presentation. As here presented, the original matter was revised, adapted, and these later installments have been specially prepared to cover the phases of construction and occupancy.—THE EDITORS.

THE first article under the above title (September issue) contained a classification of the work necessary in connection with the planning and building of industrial plants, the main headings being repeated below for purpose of reference.

P—Preliminary Service (Definition of requirements);
F—Financing;
D—Detail plans and specifications;
C—Construction work and installation of equipment;
M—Period of occupation and commencement of operation.

The article just referred to, together with the one preceding this paper, dealt in considerable detail with the seventeen sub-divisions into which the preliminary service was divided. As has been previously stated, it has been my primary purpose to emphasize that the efficiency of any industrial establishment, in the final analysis, is governed to no small extent by the effectiveness of the work done prior to the actual commencement of building operations; therefore, neither the need of speedy completion nor any other consideration can be of such importance as to justify superficial attention to it, although frequently it must be expedited by every known means.

I endeavored to point out that a result closely approaching the best attainable can be secured only through approaching the problem in a systematic manner, taking up each of the factors involved in its logical sequence, and bringing to bear, during the consideration of each, a comprehensive knowledge of the basic problems entering into the industry in question. It was shown that while many of the considerations arising at this stage are wholly special to the business that is to be provided for, there are in addition many factors which do not enter directly into the routine management of the business, but are of the utmost importance when planning the new plant. Most of these are fundamental to the laying out of all kinds of industrial plants, and are, therefore, thoroughly understood by competent industrial-engineering organizations. Consequently, if the plant or extension that is to be built is to house other than the simplest kind of work, the best results can be secured only through the joint services of those who will have to do with the management of the business after the plant has been completed, and the members of an engineering organization trained for this particular service.

Further, owing to the nature of the preliminary work, the control and direction of the co-operative service rendered by the owner and the engineers should be vested in one of the members of the latter organization, so centering in one man responsibility for the conduct of the entire operation. The engineering company should assume this responsibility because its management is especially adapted to the proper administration of the work in question, and also because the managers of the prospective plant, in most cases, should be relieved of all detail so that they can properly look after their routine duties, which are usually particularly exacting when a new plant or large extension is being built.

As the series of articles, of which this is the third, are prepared for the purpose of defining the proper procedure when planning and building industrial plants, my consideration of the preliminary service would be incomplete unless I touch upon the question of the compensation for engineering companies who specialize on this work, especially as owners become involved so frequently in cumbersome and inefficient methods of procedure, wholly through their mistaken views as to what is a fair service charge and at the same time a profitable investment.

There is no way of accurately estimating the amount of time that will be required for the preliminary work on the part of experts, as every commission presents different conditions as to the basic data that have been compiled and the thought that has been devoted to the

questions at issue prior to the engagement of specialists. The investigations made at this time may lead to a prompt solution, or they may develop a complex situation which necessitates much research and the consideration of a number of alternate plans. Therefore, the charge for preliminary industrial work performed by engineering organizations can be made equitably only upon a basis of the actual time required for its performance, rates being agreed upon in advance covering the services of various engineers. Industrial managers at times take exceptions to the rates which an engineering organization must charge for this work in order to make it yield a profit. They are primarily familiar with the sale of a product which can be weighed on a balance or measured with a rule, and on account of the manufacture in large lots, the labor charge per unit for the initial creative work that made the article possible is either practically negligible or is not taken into account. As the engineers' conclusions are made clear through the medium of reports and blue prints, which in themselves cost but a trifling sum, those who contemplate the employment of engineering experts are apt to jump to the conclusion that the daily rates represent clear profit. These rates are then compared with the salaries received by their own principals. In many partnerships or close corporations it is customary for the officers to have comparatively small drawing accounts, their real earnings being represented by an annual division of profits, and they not infrequently make a mental comparison between these nominal rates and the engineers' daily charge, and as a result conclude that the latter is exorbitant. While they are familiar with the overhead expenses that occur through the conduct of their own business, they cannot see any reason why expenses of this character, comparable with their own, should be incurred by an engineering organization. This view comes about through their failure to comprehend the gap that exists between the consulting engineer of the old school and the highly perfected engineering organization of today, employing possibly from fifty to several hundred men in office departments alone.

The actual facts are that the overhead expenses of such an engineering organization as we have under consideration will amount to about 100 per cent on productive wages when extremely favorable conditions hold. I give this figure authoritatively as a result of inquiry among leading firms. In so far as the owner or client is concerned, however, this expense should be considered to be almost as productive as the direct wages paid to men engaged on his work, as it goes to provide all the facilities and means that enhance many fold the knowledge and experience of the very men who are engaged to

his benefit. It maintains a statistical department that assures to each client not only the benefit arising through all other work done within the organization, but advantages that follow ready reference to the work of others. The average owner does not realize that if it were not for the enormous fund of data that the engineering organization has compiled at the expense of much time, it could not begin to complete the service in the time that is actually consumed, nor would the result compare in effectiveness. The housing of a large staff of men for this work involves heavy expenses, but it is through the fact that all kinds of ability and experience are available within the same office, that the organization possesses a value to its clients that could not be secured by independent workers. Those who have endeavored to carry out large undertakings through engaging a number of independent specialists are usually willing to testify to the difficulties and delays that arise. Consequently, we see that while the owner might by chance be successful in employing directly one or more engineers of unquestioned competency, he can never hope to secure those necessary adjuncts which form the backbone and fibre of the engineering organization, the maintenance of which creates the overhead charge.

Now to put it squarely, I ask those who are responsible for the planning and building of a large industrial plant "Are you willing to entrust the preliminary service, upon which the ultimate success of your entire enterprise is to no small extent dependent, to men whose training, experience, ability, and initiative have not brought them to a point where they command salaries of at least $5,000, or at the rate of about $17 per working day?" If you are not, then I say that you must add to this an additional $17 for overhead expenses, making the total cost $34 per day, so that if the owner pays $50 a day for the services of such a man, the profit to the engineering organization cannot possibly exceed $16. As a matter of fact, it is hardly necessary to point out that in even busy periods such a man's work cannot be arranged so that he is engaged at this rate for 300 days in a year, and further fluctuations in business result in an average overhead expense, taking good years with bad, more nearly approaching 125 per cent, so that the rate of $50 assures in reality but a very small margin in proportion to the value of the service rendered, which value, I wish to repeat, springs principally from the resources of the organization, and not the experience of its individual members.

The recital of facts just presented will, I hope, make it clear that expert fees ranging from $50 to $100 per day may represent only a very modest profit, whereas the far-reaching effect of the services secured through incurring such expense may be such that the amount

is wholly nominal in view of resulting economies of operation. Engineers expert in public-service work have for years been receiving these rates, the actual amount, of course, depending upon their experience and standing; and certainly the preliminary work performed by the industrial engineer is quite as far-reaching and, in the majority of cases, much more involved than the initial investigations pertaining to public-service properties.

F—Financing.

As a rule, those proposing to build extensions to existing properties or entirely new industrial plants have available in advance (or are, at least, in a position to make arrangements for) certain sums of money which, with the information at hand, they believe to be sufficient for the work. Necessarily, however, final arrangements cannot be made intelligently until the preliminary service has progressed to the point where final estimates are prepared.

It is seldom that the industrial engineer is engaged primarily for the purpose of preparing a report to be used as a means of interesting outside capital, although when it is found that the expenditure that should be made is in excess of the anticipated requirements, a concise report written by impartial experts frequently enables the principals to provide readily for the requisite amount through interests that would not co-operate if the facts were presented in a manner less specific.

It should not be expected, however, that the engineering organization will take a direct part in financing industrial enterprises, although occasionally this is expected owing to the precedent that has been established by engineers who specialize on public-service operations. The two classes of work are in no wise comparable, at least in so far as financing is concerned, and the services of the industrial engineering organization should be confined strictly to matters covered by my previous papers and those with which I will deal later. In other words, as engineers are not in a position to guarantee earnings, they should not be expected to assume the responsibility incident to interesting outside capital. The engineers are, of course, responsible for the potential possibilities of the plant provided under their direct supervision, but their engagement is invariably terminated upon the completion of the plant, so they can in no wise control the results of operation. In contrast to this condition, there are engineering organizations who perform all preliminary and detail work required in connection with public-service plants, and in addition operate the properties they have built. When they accept responsi-

bility for all these functions their interest becomes, in a certain sense, that of engineer and owner jointly, and the opportunity is afforded to substantiate their own predictions as to gross income, operating expenses, etc. Under these circumstances, if it is desirable, the engineer can conscientiously take a hand in the financing of new work.

I have dwelt upon the above only for the purpose of emphasizing an understanding that should be primarily established as a basis for any arrangement covering the employment of professional men; namely, that the limits of responsibility for the securing of results by a certain procedure should be clearly defined, the responsibility ceasing with the surrender of the control of matters upon which the predicted results depend. The confidence that must necessarily be placed in engineering organizations by those employing them for preliminary industrial work is evidenced by the fact that their recommendations are accepted with the knowledge that it will be the owner's responsibility to prove during subsequently operations the correctness of the plant in all its details.

D—Detail Plans and Specifications.

I will assume in connection with all that follows that the preliminary work has been properly completed, resulting in an exact definition as to the entire physical requirements of the plant, so that the work under this heading resolves itself mainly into the selection of such standard apparatus and construction appliances as will most efficiently meet the specified needs, and the preparation of detail plans for the buildings and for special features that cannot be secured in the open market and must, therefore, be built to order. In either instance, the character of the equipment, materials, or work required is defined through the medium of drawings and specifications, and the efficiency with which the requirements are met depends principally upon the manner in which these are prepared and the purchasing negotiations conducted. As the procedure varies considerably, depending upon the particular feature of the plant that is under consideration, I will briefly consider the subject under each of the sub-divisions that were enumerated in my first paper.

D-a. Prepare plans and specifications for special machinery as defined by preliminary work.

As this sub-heading relates specifically to special machinery, the drawings and specifications prepared, in order to assure the provision of suitable apparatus, must be in much more detail than is necessary when the conditions can be fulfilled by standard equipment. No fixed rule can, however, be laid down as a guide, for in some cases an exact

definition of the work that is to be accomplished and a general description of the characteristics of the machine that is needed are all the data that it is desirable to place in the hands of those competent to submit bids, whereas in other instances detail designs should be fully worked out, thus relieving the builder of all responsibility other than that pertaining to a strict compliance with the drawings and specifications. Special apparatus of this character is usually provided for directly by the owner, as his experience should qualify him in such special matters to an extent that would hardly be possible with the engineers.

D-b. Prepare plans and specifications for all other industrial physical features defined by the preliminary work.

This sub-heading pertains to all equipment and apparatus required directly in connection with manufacturing or process work other than the special machinery just mentioned. The majority of industrial companies depend for the performance of the greater part of their work upon standard equipment and apparatus that is built for the trade, and the mistake is often made of believing that the selection of equipment of this character is a comparatively simple matter and does not require the consideration that should be given to the more special features. As a matter of fact, there are available for most trades so many different makes and types of apparatus designed for the performance of essentially the same work that it is by no means a simple matter to select the particular equipment best suited to a given purpose. In the machine-tool business, for example, manufacturers of engine lathes, boring mills, milling machines, drilling machines, etc., have designed their particular output for the performance of work coming within certain well defined limits as to size, accuracy, and speed of operation, and the existing differences must all be taken into careful account when purchasing machine tools for a given business. As the leading machine-tool builders have established their reputations through their ability to carry out their guarantees, it is sufficient when soliciting bids to forward to them a concise statement of the character of work that is to be done, and to ask that complete data be submitted as to the details of the machine recommended and the rapidity with which the operations can be performed. There are, of course, certain matters concerning which machine-tool builders should be posted, such as the system of motor drive that is desired if the machine is to be electrically equipped, the kind of tool steel that is in use, and any other features bearing on the machines' operation that have been standardized for the shop in question. A careful comparison of the information returned with the

bids will promptly reveal the detail features in which they differ; and this understanding, coupled with a knowledge as to the performance of the machines in other plants, forms the basis for final judgment.

What I have just said applies generally to the purchase of woodworking machinery, textile machinery, cement-making machinery, and all other standard types of manufacturing equipment. Such equipment is usually purchased by those who will have to do with its operation after the plant is completed, although occasionally engineering organizations are engaged to handle this work.

D-c. Prepare plans and specifications for power generation, transmission, and driving equipment to meet the established requirements.

The principal work in connection with the selection of this equipment is completed when the plant requirements have been fully defined. As this is a matter that was touched upon in a previous paper it need not be dealt with here. A decision having been reached as to size of power units that will be required, the kind of current needed for power and lighting purposes, etc., it is necessary to figure out carefully, unless the data are already available, the cost of power-plant operation based upon the installation of the various types of apparatus that are available. The determination of the character of the prime mover is followed by the choice, if steam is to be used, between turbines and reciprocating engines, and if the latter, simple or compound, condensing or non-condensing.

Having narrowed down each other important feature in the same way, specifications should be drawn in such manner that while details as ratio of heating surface to grate area, steam pressure, piston speed, current density of electrical conductors, etc., are all confined to limits that experience has proved to be satisfactory, yet restrictions will not be made that prohibit fulfillment of the requirements by standard makes of equipment built by reliable companies.

There are certain features in connection with the power and driving equipment which, as a rule, must be designed before bids can be properly solicited. I have in mind principally the piping, wiring, switchboard, line shafting, and transmission equipment generally. It is in regard to these matters that adherence to a definite procedure is of special importance. The contractors for the piping and wiring and other items referred to will volunteer to submit their own designs, but this course should not be permitted as there will be no definite basis for comparison of bids and the work will be done by parties who are not conversant with the operation of the whole, and under conditions which are not favorable to proper protection of the own-

er's interest. The conditions are quite the reverse of those existing in the machine-tool trade, for example. In the latter instance, not only does the acceptance of the builder's design permit of the purchase of a standard machine, but years of research and practical experience have enabled the leading machine-tool builders to attain a proficiency in matters of design that is wholly beyond any result that could be obtained by any one not directly in the business. A piping layout, however, is a made-to-order proposition, differing totally in its nature from the illustration just cited, and its proper solution can be best worked out by an engineer specializing on steam installations.

D-d, e, f. Prepare plans and specifications for equipment needed to provide artificial lighting, ventilating and heating, and sanitary arrangements needed to meet fixed requirements.

The same procedure as was outlined in connection with the power plant, wiring, and piping work applies to the features included under these sub-headings. A certain amount of designing must in each case follow the decision as to the system or type of equipment that will be used, but the designing will have to do principally with broad considerations, such as the number and location of lighting fixtures, the amount, character, and location of pipe coils or radiators, the size and location of ventilating fans, vacuum pumps, or other apparatus necessary to the proper fulfillment of these requirements. Minor details of construction should be left open to as great an extent as possible.

D-g. Prepare plans and specifications for fire-prevention apparatus based upon the conditions established by the preliminary work.

During the course of the preliminary work decision will have been reached as to provisions that are to be made for fire prevention. This may be indirectly accomplished, in part, through the adoption of thoroughly fire-proof structures and, in certain cases where the buildings house non-combustible contents, little or no fire-fighting apparatus need be installed. In the majority of cases, however, pressure lines must be provided for the distribution of water to suitably located outlets for hose connections and to sprinkling systems, and in such cases the standards established by the various insurance inspection bureaus and by the Associated Factory Mutual Insurance Company should be adopted as a guide when preparing plans and specifications. Here again the specifications that are sent out when soliciting bids should be sufficiently complete to assure a fixed basis for the comparison of quotations and the adherence to specific types of apparatus and details of construction that are particularly desired.

D-h. Prepare plans and specifications for the complete building or buildings, so prepared as to harmonize with the plans and specifications covered by headings D-a to D-g inclusive, and to meet requirements defined by preliminary work.

The method of preparing the plans and specifications for the buildings depends, of course, to a considerable extent upon the type of construction that is adopted. Buildings, considered as a whole, are essentially a built-to-order proposition; but of course they must be designed with a view to utilizing, to as great an extent as conditions will permit, standard materials and such standard features as metal window frames, sash-operating devices, ventilators, skylights, post caps and hangers, etc. It may be that in time the buildings required to house industries of a certain character will be standardized, units being built for certain established outputs, but in the majority of cases the buildings will always be special for each business that is to be accommodated. Conditions cannot be otherwise until every detail comprising the internal arrangement of the buildings has been standardized. Owing to the multiplicity of factors that are involved, the room that exists for differences of opinion, and the range in the desires of owners as to capacity, this result, if ever accomplished, will be attainable only in certain businesses where the processes are clearly defined, such as cement plants, rolling mills, etc.

The cost incurred through the construction of "made-to-order buildings" compared with what it would be if they could be standardized is not, however, as much greater as might be supposed, as in any case it is necessary to construct each job separately at the location that has been selected; and if the plans and specifications are properly prepared for the various parts of the buildings that are bought wholly or partially assembled, such as the structural steel work, mill work, etc., the repetitive manufacturer will make the shop costs compare favorably. Building costs are, however, influenced to a much greater extent by the character of the plans and specifications than is generally supposed, and this is particularly true in so far as the actual field costs are concerned. Those familiar with the status of the various building trades that must be employed in conjunction with the erection of buildings realize fully the need of minimizing field work, on account of the high wages exacted; so they aim to have as much of the fabrication provided for prior to shipment as conditions will permit, and to use every means to economize field expense.

As a general proposition, complete plans and specifications covering all features entering into building structures should be prepared prior to soliciting bids; but this work must, of course, be done by men

thoroughly conversant with all available standards and the usual practices adopted in shops which will be called upon to submit quotations on the work. The fact that these detail prices may be solicited by a general contractor rather than by those who prepare the plans has no material bearing upon the situation. It is particularly important that structural steel frames should be designed, in so far as size of the members and the character of the connections are concerned, before quotations are solicited, for it is only in this way that bids can be secured which can be properly compared, and a structure assured that will meet, in every particular, the multiplicity of industrial requirements. The same reasoning holds true in regard to all other features and, of course, in any case the effectiveness of the result is dependent upon the familiarity of the architects and engineers with the work in hand.

A somewhat special condition has arisen as a result of the rapid strides made by the reinforced-concrete systems for the construction of industrial buildings, and it is likely to be several years before an established basis of procedure can be definitely laid down. At present there are various systems of construction, each of which is advocated by one or more contractors, and many admirable examples of their work can be cited. In cetrain cases these systems are patented, in part at least, and the building of large reinforced-concrete structures has become established as a thorough specialty, for reasons which are too well understood to need repetition here. At the present stage of development it is undoubtedly desirable, at least in connection with structures of considerable magnitude, to prepare plans and specifications of such a nature that the reinforced-concrete specialists can bid upon their own detail design as worked up to meet the proposed conditions, submitting with their bid such data as may be necessary to enable thorough understanding as to the details of the proposed system. If all of the specialists figured upon the same system, this course would not be desirable, and it is not unlikely that at no very distant date this result, with the exception of minor matters, will have been reached.

One of the advantages in handling the preliminary work in the thorough manner described is that the buildings can be designed with a full knowledge of all the more important industrial requirements, so avoiding subsequent alterations, cutting of pipe openings, drilling the reinforced concrete, etc.; but even when the preliminary work is properly conducted many of these details are likely to be overlooked unless the plans and specifications are prepared in accordance with a carefully arranged schedule.

D-i. Prepare plans and specifications for yard provisions that must be made to meet fixed requirements.

It is almost always necessary, when building an industrial plant, to make certain installations in the yard area between or around the buildings, but in so far as this discussion is concerned, these matters are too intangible for detail consideration.

D-j. Prepare contracts to accompany plans and specifications when soliciting bids, so drawn as to provide proper protection for both the owner and the contractor.

A separate paper could well be written upon the subject covered by this sub-heading, for it is a very important matter to have the relations of owner and contractor not only clearly established in so far as the actual scope and character of the service is concerned, but to provide adequate protection to both parties in regard to the legal questions that may arise and that usually assume somewhat different aspects in different States or cities. When arrangements are being consummated for the performance of a large and complex piece of work, it is always desirable to have prepared a contract clearly defining the duties of the various parties and, while legal advice should be sought, it is important that the papers should be primarily drawn to define a mode of procedure which actual knowledge as to the work required dictates as being the most efficient one. A form of contract suitable for the erection of a reinforced-concrete building is wholly unadapted in many of its clauses to the purchase of most industrial or service equipment.

In many cases a standard form of purchase order is all that is required when contracting for equipment or material entering into industrial operations, and the conduct of a large enterprise is greatly simplified when the awarding of contracts and purchasing of material is in the hands of parties whose judgment in regard to this and many other matters that arise is guided by a comprehensive experience gained through the repeated performance of such service. This question of the letting of contracts and providing of equipment and materials will be taken up in further detail in the paper to follow.

I fear that the brief manner in which it has been necessary for me to touch upon the method of preparing detail plans and specifications required in connection with the building of industrial plants will give a quite inadequate understanding as to the character of the service in question, except to those of my readers who are to some extent familiar with the work. It is not necessary, however, for those who intend to build an industrial plant or to extend an existing property to be familiar with the manner in which each of the engineering de-

tails should be cared for, but it is of the utmost importance that they should be properly advised as to the general procedure that will bring about an efficient result—that is, to whom should the work of preparing detail plans and specifications be entrusted.

While the value of the services of engineers in connection with the preliminary work has not received pronounced recognition until within the past few years, it has for a long time been customary to engage architects for the purpose of having prepared building plans and specifications, and engineers have been employed almost as generally in connection with the purchase and installation of equipment for lighting, heating, and power purposes. As a matter of fact, architecture, in the strict sense of the term, usually plays a minor part in connection with the building of an industrial plant, as all matters having to do with the integrity of the structures are purely engineering considerations. If an architect is competent to handle the work that we have under consideration, it is because his organization comprises engineers possessing the training and experience which the operation necessitates, or that he associates with engineers for the purpose of securing this end. On the other hand, an engineering organization fitted for the proper performance of this work must either include among its members one or more competent architects, or depend upon their ability to secure the co-operation of architects practicing independently. However, engineering companies, as they attain reasonable proportions, invariably find that their work can be efficiently handled only through the inclusion in their own ranks of all the various kinds of ability demanded for the complete performance of the majority of commissions secured, so that I will assume that the term "Engineering Organization" includes as one of its functions the performance of such architectural service as enters into industrial operations.

Occasionally an industrial company that maintains a designing department, as a regular part of its organization, decides to prepare through its own force the plans and specifications required for an addition to its plant, believing that its needs can be efficiently cared for by merely augmenting its staff. As this view is now but rarely evidenced, I would not take the time to point out wherein it is fundamentally in error were it not that by so doing I hope to make more clear the administrative conditions necessary for the efficient handling of the work.

In the first place, the designing department or drafting room required by a manufacturing company operates under conditions that are radically different from those governing the administration of

the same department of a company organized especially for the purpose of handling miscellaneous engineering operations, so that while the employment of engineers or draftsmen familiar with building work may provide a part at least of the technical and possibly practical knowledge that is required, it does not provide that much more essential element which I will describe as an efficient organization for control. Of course, the owners may to some extent appreciate this fact and so start out with the intention of employing a first-class man to take charge of the work in its entirety. If by chance they are successful in this, the man so engaged will insist upon entire control in accordance with his own views, so that the owners, to all intents and purposes, will have engaged an engineering organization, but one which cannot bring to bear upon the solution of their problems the advantages of the data and systematic co-operation which would be available if they engaged an established engineering firm.

It may be asked why I consider the industrial company incapable of economically preparing its own detail plans and specifications, and my answer would be briefly as follows: The entire scope of experience which the management of the industrial company can bring to bear upon the problem is incorporated in the conclusions resulting from the preliminary work. The preparation of detail plans and specifications are matters which are wholly outside of the specialty in which they are engaged, so they are handicapped at the very beginning through their inability to judge as to the competency of the men they employ, and they are equally unable to check properly the value of the work that is done. If, on the other hand, the industrial company decides to engage an engineering organization, no attempt need be made to determine the ability of the individuals comprising the various organizations under consideration, but decision must necessarily be based upon an investigation of their work for others.

Assuming, however, that engineers and draftsmen are engaged first hand by the industrial company, let us consider their probable environment. They will find that the existing designing force, if there is one, is performing work which is in a certain sense quite independent of the routine manufacture performed in the plant, this being more true as the work is more nearly repetitive in character. The designers are usually working upon modifications of the output which the company expects to place on the market at some future date with a view to improving its character, reducing its cost, or both, and the drawings are necessarily made the subject of minute discussion upon the part of all the principals and department heads. Drafting-room expense which at first sight might appear to be exorbitant

may in reality be more than justified through the enormous repetition of an increment in saving. The conditions in regard to the work for which the new men are employed are, in many respects, diametrically opposed to those just defined. In so far as the buildings proper are concerned, it is only the big things (which are readily evident, and all defined by the preliminary work), that bear upon economy of future operation, and such minute attention to details as is usual with the designer employed by an industrial company is wholly unwarranted. By this I do not mean that the work can in any way be slighted, but rather that the members of an engineering company organized for the designing of new plants are trained to understand that designs which are for something that has never been built before, and will probably never be used again, must be made right the first time, and it is the province of the engineers to define the limits of accuracy that are appropriate for each case. Now, it is just at this point that the industrial organization attempting to do is own work becomes involved in needless confusion and expense. Irrespective of the training that the draftsmen engaged for the purpose may have had, the chief engineer or chief draftsman will unconsciously endeavor to apply his customary methods; and in this he is at a further disadvantage through his lack of familiarity with the methods and practices of the shops that will be called upon to build the parts that are being designed. It is especially hard for him to acquire the mental attitude that permeates the successful engineering organization, and springs from the knowledge that as long as the work is in the drawing room, the field work is wholly or partially delayed. In fact, the habit of discussion and revision is so much a part of industrial management that it is frequently responsible for the expenditure of weeks where as many days should be sufficient.

We need not at this time discuss further the advisability of engaging engineering specialists for the purpose of preparing detail plans and specifications for industrial plants. If any of my readers are particularly interested in this matter, they should read the admirable article published in the May, 1908, issue of THE ENGINEERING MAGAZINE written by Mr. Frederick W. Bailey. In criticism of the practice of industrials who design and build their own plants, Mr. Bailey concludes:

> Such a system, of course, will eventually hang itself. Plants will finally cost so much to build that they cannot be operated at the profit which competitors make. Finally, perhaps upon the consolidation of several plants, a broader view of specialization will come to those in control, and it will be seen that true economy lies in letting engineers build the plants, while operators confine themselves to operating them.

THE BERLIN SYSTEM OF CENTRAL STATIONS.

By Frank Koester.

Mr. Koester's article is based chiefly upon data and illustrative material supplied direct to him by the Director of the Berliner Elektricitäts-Werke, but acknowledgment is made to the *Zeitschrift des Vereines deutscher Ingenieure* for supplementary figures and for the line cuts here reproduced.—THE EDITORS.

IMMEDIATELY following the Paris International Electrical Exhibition of 1881, where Edison exhibited his incandescent-lighting system for the first time, the engineer Emil Rathenau, at that time one of the most progressive engineers in Germany, and at present general director of the "Allgemeine Electricitäts Gesellschaft" and the "Berliner Electricitäts Werke," recognized the great advantage of the system and he immediately took steps to provide the city of Berlin with a complete electric-lighting and distributing system on the order of the municipal gas-lighting systems then in use.

He organized an experimental company at first and on May 5, 1883, the "Edison-Gesellschaft für Angewandte Electricität" was formed, which today is the well-known "Allgemeine Electricitäts Gesellschaft." In February, 1884, the original company contracted with the city of Berlin for building central stations and supplying electric light, and secured concessions to lay conduits either under street or sidewalk from a central station. The district so supplied was that comprising the "Werder Market" and took in a radius of 800 metres (2,625 feet). This company also had a concession to organize a new company for the purpose of operating the central stations, and in May, 1884, the Municipal Electrical Works, which today is the "Berliner Electricitäts Werke," was formed and the growth of this company and the operation of this system of central stations and distribution is the subject of this article.

The "Allgemeine Electricitäts Gesellschaft" will hereafter be referred to as the "A. E. G." and the "Berliner Electricitäts Werke" as the "B. E. W."

The first two central stations put in service were the "Markgrafen Street Station" and the "Mauer Street Station," the former consisting of six steam engines of 150 horse power each which were housed in

a building 140 by 145 feet, the other consisting of three engines of 150 horse power each, and put in operation August 15, 1885 and May 1886, respectively.

These two plants soon become inadequate for supplying the demand and the city granted new concessions in August, 1888, for the supply of electric light to a much larger territory; two additional central stations were erected, one on Spandauer Street and the other at the "Schiffsbauerdam."

Within less than two years thereafter it became necessary to secure a new franchise and in this the rights of the company were restricted in the following manner: No additional central stations were permitted to be erected in the heart of the city, and the output of these four power plants was limited to 28,000 horse power.

Under these conditions the company was soon obliged to install a storage battery sub-station at the western end of distribution for the purpose of storing up when the load was light and assisting the central stations during peak hours.

In the year 1896, during the Berlin Exposition, the company undertook to supply current for electric traction and motive power for the Exposition and, with the increase generally of the industry, the full 28,000 horse power was utilized. In 1898 and 1899 storage batteries were installed on a large scale; 4,000 horse power at the Mauer Street station and 2,000 horse power at the Schiffsbauerdam station.

At this time the first motor-generator sets were installed at the Markgrafen generating station and in the first storage-battery substation in Koenigin Augusta Street, the motors of which received three-phase current from the Schiffsbauerdam station at 3,000 volts.

The limit of capacity had now been reached, and the company's charter was about to expire in 1899. A new agreement was therefore entered into in April of this year, the conditions being as follows:

1. The city reserved the right to acquire by purchase, in the year 1915 (October 1), the complete works of the company.

2. The B. E. W. undertook, for itself and the A. E. G., to turn over to the city in 1915 any and all properties which the latter company might at that time control pertaining to this system of current generation and distribution, covering a territory of 30 kilometres (18 miles) in diameter.

Simultaneously the city entered into an agreement with the A. E. G. whereby the latter company obligated itself to turn over these properties to the B. E. W. at their cost.

3. The city received 50 per cent of the net profit of the company over and above a 6 per-cent dividend on its capital stock up to 20,000,000 marks, and over and above a 4 per-cent dividend on the capital stock in excess of 20,000,000 marks.

4. The collection of rent for current meters was abolished and the fee charged for testing installations was reduced from 10 per cent to 4 per cent.

5. The city agreed to obligate the traction companies to secure their current from the plants of the B. E. W. at not exceeding 10 pfennigs (2½ cents) per kilowatt hour.

6. The B. E. W. was permitted to extend its system of distribution throughout the entire city. The capitalization of the company was limited to the requirements of a system with a total capacity of 42,500 kilowatts within the city limits and 37,000 kilowatts for the suburban plants.

As this contract was limited to a short operating period of 16½ years, to make as great a commercial success as possible during this time, it became necessary for the company to build new plants in the shortest possible time and to boost the sale of current likewise.

Experience had already shown during the early years of the enterprise that the location of generating stations in the heart of the city was anything but desirable, as large tracts of property were difficult to secure in such sections and facilities for the transportation of machinery, building materials, fuel, ashes, etc., were not of the kind to further economy. And, furthermore, as the dust and dirt, even from a well equipped power plant, cannot be entirely eliminated, it was settled for once and all that all generating stations must be located in suburban districts and the current be brought to the heart of the city in the form of high-tension voltage, stepped down in sub-stations for distribution. This plan has now been adopted in practically all European cities.

The A. E. G., prior to the closing of the last mentioned contract, had already erected a plant of 6,000 horse-power, consisting of two 1,000 horse-power and two 2,000 horse-power engines at Oberschöneweide, an industrial suburb in the eastern section, which under this contract had to be acquired by the B. E. W. It was at first intended to enlarge this station as necessary, up to 80,000 kilowatts (the limit of contract capacity). It was finally decided, however, to erect an additional station to supply the northern and western sections, rather than to depend upon a single generating plant with all the possibilities

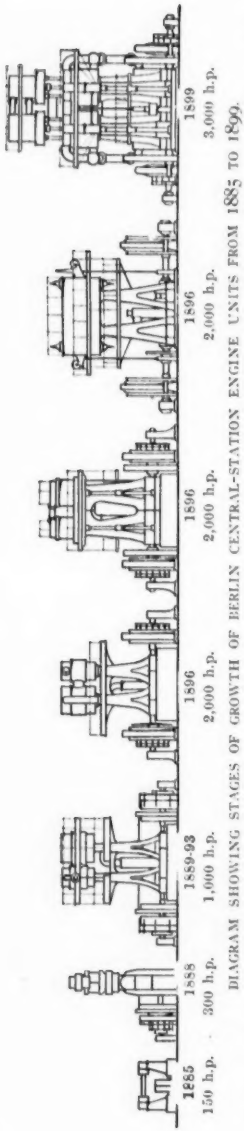


DIAGRAM SHOWING STAGES OF GROWTH OF BERLIN CENTRAL-STATION ENGINE UNITS FROM 1885 TO 1899.

of interruption of service due to shut downs that might be unavoidable.

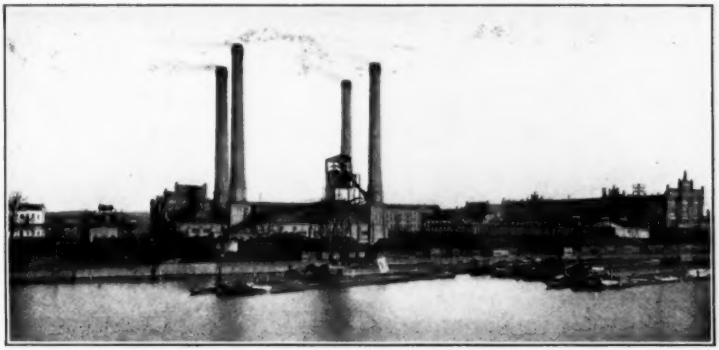
As the A. E. G. had already entered into contracts for supplying several surrounding districts, these were accordingly turned over to the B. E. W.

These two plants, the one known as the Oberspree, supplying the districts Obershöneweide (in which this plant is located, as stated), Niedershöneweide, Alt-Glienicke, Ostend Adlershof, Johannesthal, Grunau, Rummelsburg, Sadowa, Karlshorst, Friedrichsfelde, Friedrichsberg, Britz, Stralau, Cöpenick and Rixdorf; the second plant, known as the Moabit, supplying Spandau, Pankow, and Reinickendorf.

The current from the generating stations is distributed through underground conduits by three-phase 6,000-volt, and stepped down for distribution to three-phase 220-volt current.

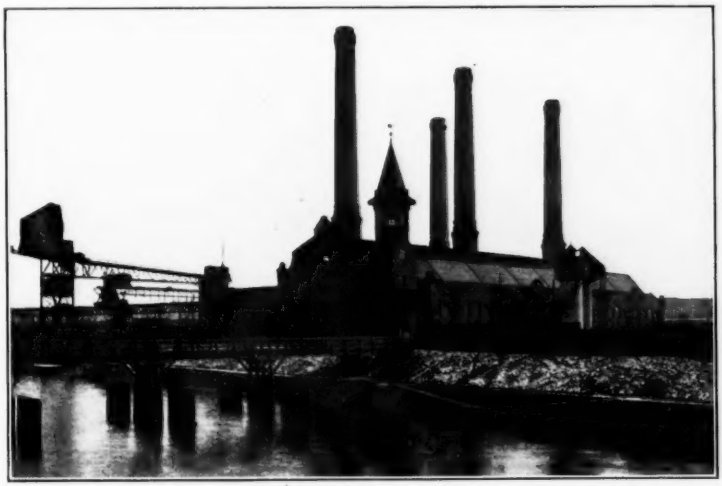
Comparing the size of units used in the first plant erected in 1885 and those of the Louisenstrasse plant erected in 1899 it will be of interest to note that the small 150-horse-power engines of the former plant were of the compound high-speed type (210 r. p. m.) each being belt-connected to three generators, while the units used in the latter plant were four-cylinder, triple-expansion, 3,000 horse power. The dimensions of these engines were already of such proportions that it became necessary to use two low-pressure cylinders.

The successive steps in sizes of units is well illustrated in the accompanying diagram, all of them being vertical engines. As the plants, up to this date, were located in the heart of the city, where space was valuable, the vertical type of engines was employed and the

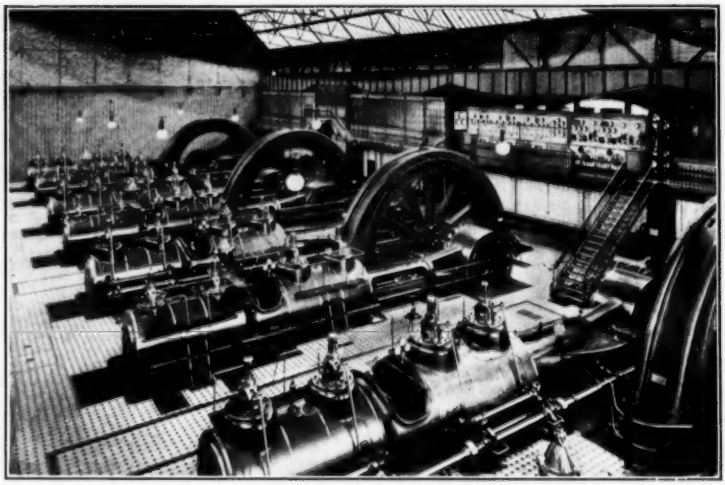


THE OBERSPREE LIGHT AND POWER PLANT.

boilers were located on a floor above them, the plant at Louisenstrasse having three 3,000-horse-power units occupying a ground area of 561 square meters, or 0.67 square feet per horse power, or practically 0.90 square feet per kilowatt. Modern American plants, in cities where ground is still more valuable, and where vertical engines are also used, show up with the following ground areas per kilowatt capacity: Waterside Station, No. 2, 0.80 square feet; 59th Street Station, 2.32



THE MOABIT PLANT, BERLIN.



INTERIOR OF THE MOABIT PLANT, BERLIN.

square feet; 74th Street Station, 2.05 square feet; 96th Street, 1.40 square feet; and Kingsbridge, 1.88 square feet per kilowatt. It must be stated, however, that these stations have boiler rooms, some of them two and three-decked, adjacent to the engine rooms, and that larger units are employed; for instance, the 59th and 74th Street stations emp'oy units of 5,500-kilowatts normal capacity. These circumstances are important in their influence on economy.

Beginning with the time when the Berlin generating plants were located in the suburbs, where more space was available, the horizontal type of engine was generally adopted, the later engines of the Oberspree plant being of the triple-expansion, four-cylinder, horizontal type, 3,000 horse power, with high-pressure cylinder 32.5, intermediate cylinder 49, and the two low-pressure cylinders 58 inches in diameter. In accordance with Continental practice they were of poppet-valve type, each engine operating, from the crank shaft, its own jet condensers, one for each low-pressure cylinder, and they were designed for 175 pounds working pressure and the use of superheated steam of a total temperature of 600 degrees F.

Tests conducted under ordinary operating conditions show steam consumption as follows, with both superheated and saturated steam and a pressure in all cases of about 175 pounds per square inch, the figures being in pounds of steam per indicated horse power per hour.

TESTS OF 3,000-HORSE-POWER ENGINES (OBERSPREE).

600 degrees F. total temp. in pounds.	475 degrees F. total temp. in pounds.	Dry saturated steam in pounds.
8.910	11.704	11.528
8.932	11.572	11.374

Considering the economy in steam consumption generally secured in engine practice at this period (1902), 8.9 pounds per indicated horse power under ordinary operating conditions certainly shows remarkable results and compares most favorably with the results secured even in today's practice with either reciprocating engines or turbines. It must also be remembered that the steam for operating the condensers is included in these figures.

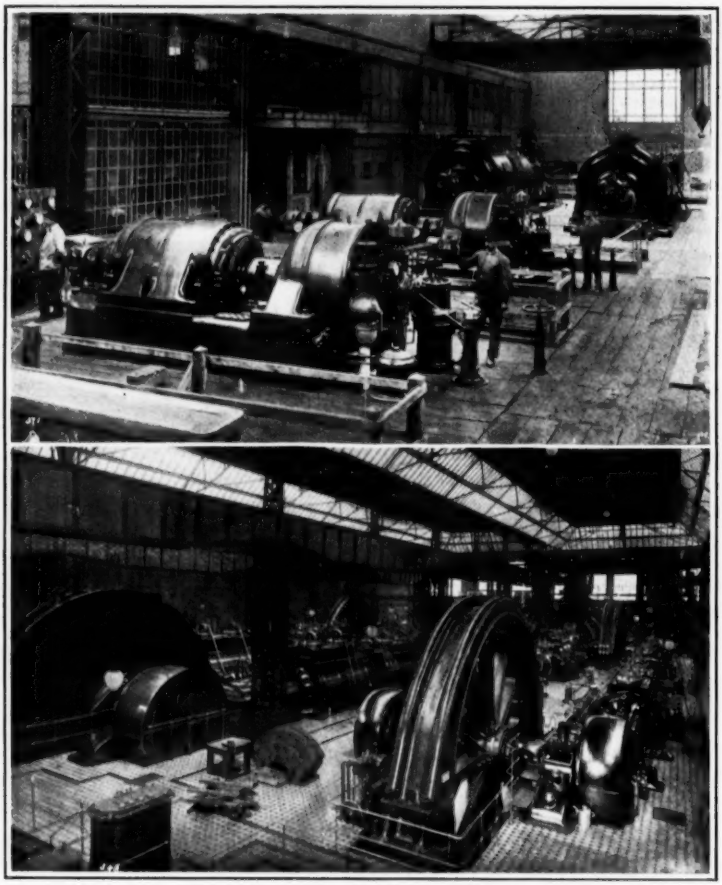
During the period 1902 to 1908 we find an increase in the size of units employed, from 3,000 horse power to 6,000 horse power and, of course, during this period the steam turbine was also introduced and the total capacity of the plants of the B. E. W. was increased from 62,260 horse power to 153,810 horse power, while the boiler heating surface in use increased from 265,825 square feet to 475,527 square feet. Thus, the engine capacity increased 247 per cent and the boiler heating surface increased but 179 per cent, showing that the total efficiency of the plant has been increased considerably.

In the year 1905 three different makes of engines of 6,000 horse power each were installed in the Moabit plant, using superheated steam of 175 pounds working pressure and a total temperature of 572 degrees F. These engines, although of different makes, were of the same type and practically of the same dimensions, being four-cylinder, triple-expansion, horizontal. The average steam consumption of each of these three engines varies from 8.80 to 9.20 pounds per indicated horse-power hour.

It will be noted that the steam consumption of the 1902 engines was practically the same as that of the 1906 engines, so that the increase in economy of the later installations as a whole is to be traced to the boiler room.

The statement frequently made, particularly of late years, since the introduction of turbines, that prime-mover economy does not necessarily mean plant economy as a whole, is contradicted so far as this Berlin plant is concerned. As this plant showed no further increase in engine economy but a decided increase in boiler economy, the plant economy as a whole has shown a decided improvement.

With the introduction of the turbine the possible economy of this new type was well considered before its adoption by the B. E. W.



INTERIOR OF TWO SECTIONS OF THE OBERSPREE CENTRAL STATION, BERLIN.
The older installation is shown below. The view of the turbine section, above, shows two of the three 5,000-kilowatt Brown-Boveri-Parsons turbines and two 1,000-kilowatt A. E. G. turbines.

plants, and tests of 3,000, 4,000 and 6,000-kilowatt turbines working under a pressure of 185 pounds and a vacuum of 95 per cent, and a total steam temperature of 372 degrees, 617 degrees and 662 degrees F., showed a steam consumption of 13.2, 12.5 and 12.1 pounds per kilowatt-hour respectively for these temperatures.

At present there are installed four 1,000, five 3,000, four 4,000,

three 5,000 and one 6,000-kilowatt turbo-generator units, making a total turbine capacity of 56,000 kilowatts, or 76,000 horse power.

The total capacity of the plants, including reciprocating engines and turbines, now exceeded the limit of the existing contract with the city and a new contract was entered which did not stipulate any limit as to capacity of plants, but required that the B. E. W. furnish all current necessary for lighting, power, etc.

Pending the negotiations leading up to this contract, the increase in the demand for current was such that the B. E. W. obligated itself to increase the capacity by 34,000 horse power within ten months. This necessitated extraordinarily rapid work, and great credit was due not only to the B. E. W. but also to the A. E. G. who had to design, construct, and install all the turbines, generators and the entire electrical equipment within the time specified.

While in the short time available ground could readily be acquired in the neighborhood of the Oberspree plant, where the new Rummelsburg plant is at present located, it was found impossible to secure available land adjacent to or near the Moabit plant. Therefore it was decided to abandon one of the 3,000-horse-power (1,800-kilowatt) four-cylinder, triple-expansion engines and to install in its place three turbo-generators of a total capacity of 19,000 horse power, or approximately 13,000 kilowatts.

The present Moabit plant consists of six reciprocating engines and six turbo-generators, with a totai capacity of 34,750 kilowatts, and 41 boilers with a total heating surface of 141,955 square feet.

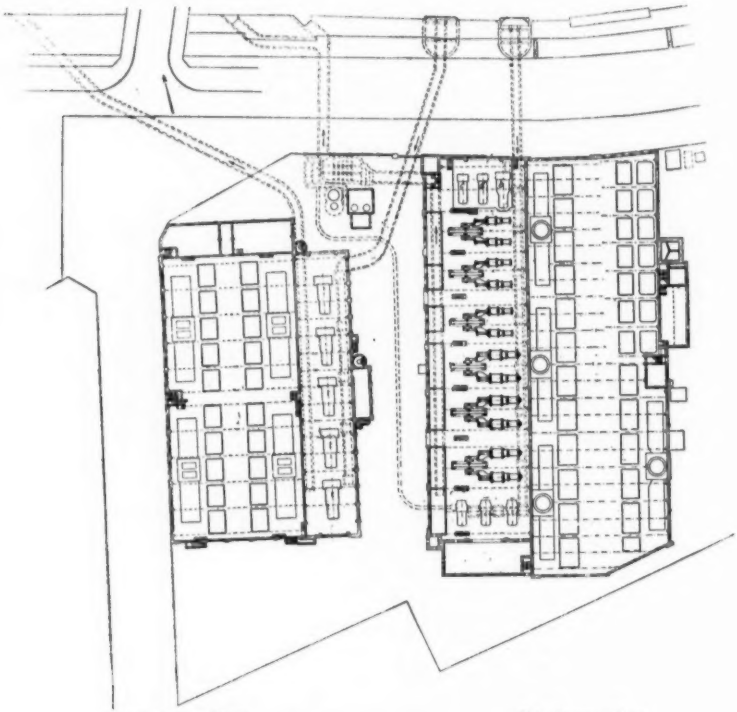
As time went on the company was able to acquire ground in the Moabit district for a new plant which is now building and will have an initial equipment of two 6,000-kilowatt turbo-generators and five boilers with 4,450 square feet of heating surface each. This plant is located adjacent to and parallel to the Moabit plant No. 1 and is called "Moabit No. 2." It is designed to accommodate two 6,000 and three 7,500-kilowatt turbo-generators, making a total of 34,500 kilowatts.

The total capacity of the Oberspree plant after its extension, consisting of eight reciprocating engines and eight turbo-generators, is 31,800 kilowatts, and forty-four boilers with a total heating surface of 153,700 square feet.

As the time for completing these improvements was limited, three of these turbo-generators (5,000-kilowatts each), were supplied by Brown, Bóveri & Co., Mannheim-Baden.

The Rummelsburg plant, designed to assist the Oberspree plant

to supply the northern section of Berlin with current, is designed to accommodate twenty-four boilers with a total of 110,000 square feet of heating surface and eight economizers each having 8,600 square feet of heating surface. The present equipment of the engine room consists of three 4,000-kilowatt turbo-generator units of a total capacity of 12,000 kilowatts, while the maximum capacity of this plant will be about 22,000 kilowatts.

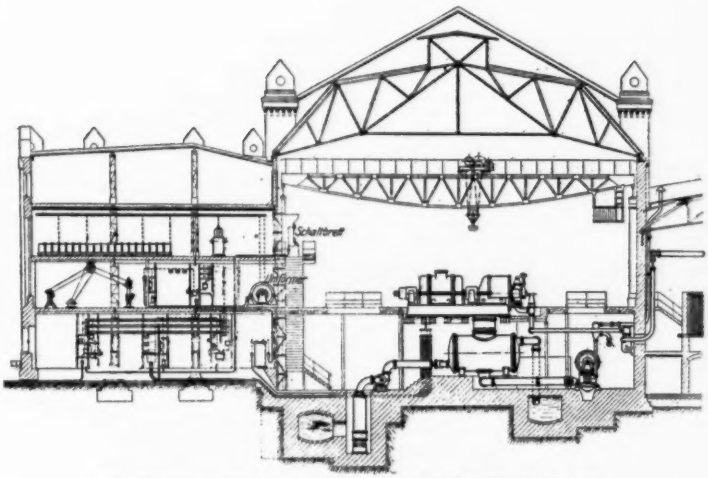


New Power Plant. Old Power Plant.

PLAN OF MOABIT CENTRAL STATIONS, NOS. 1 AND 2.

Having given a history of the development and the economy in the generation of current, it remains to take up the development of the boiler room and coal and ash handling systems.

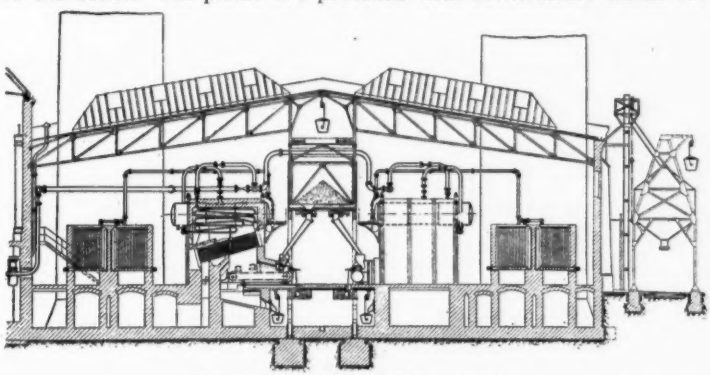
In general the water-tube type of boiler has been adopted for these plants, different makes of German boilers having been selected,



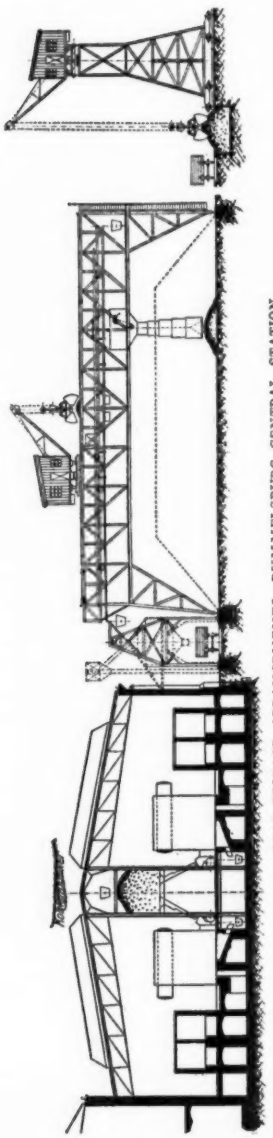
GENERATING AND SWITCHING ROOM, RUMMELSBURG PLANT.

and of late years the Babcock & Wilcox boiler, as manufactured in Germany, has also been installed, as well as different types of mechanical stokers for the later installations.

As skilled labor at low wages was readily obtainable in Germany, the mechanical stoker did not get a foothold there as promptly as it did in America, nor to such an extent. The boilers, in nearly all cases, are provided with superheaters of large heating capacity, being usually placed within the boiler setting and, in some cases, on the top of the boiler. All plants are provided with economizers which are



BOILER HOUSE, RUMMELSBURG PLANT.



COAL-STORAGE ARRANGEMENTS, RUMMELSBURG CENTRAL STATION.

located in the rear of the boilers, with ample space surrounding them, as the floor space occupied in these new suburban stations is not limited as that of the earlier plants erected in the heart of the city. The standard arrangement locates the chimneys in the boiler room between two economizers, and the gases from a number of batteries may pass through these or directly to the chimney. Contrary to American practice, the smoke flues are carried down and through the basement, entering the economizers from below, permitting low and well ventilated boiler rooms, not possible with the use of steel smoke flues, which not only require much head room and obstruct the easy planning of the piping systems, but radiate an excessive amount of heat into the boiler room, simultaneously reducing the efficiency of the chimney.

Nearly all plants are provided with suspended bunkers, located between the boilers and over the firing aisle, which are, however, usually smaller than found in American practice, for the reason that large coal-storage capacity is furnished adjacent to the boiler room. As the plants are all located on a stream, the coal is unloaded from barges by means of traveling hoists and grab buckets, and dumped into chutes, from which it is fed into dumping buckets suspended on and carried by endless cables directly to the coal bunkers in the boiler room or to the coal piles in the storage yard. Extra precautions have been taken to prevent the dust usually scattered about in

dumping coal on the ground or in piles. This is accomplished by providing the gantry cranes with telescoping chutes which close up to conform to the increasing height of the coal pile, as may be seen in the illustration showing the coal-handling system of the Rummelsburg plant.

The ashes from the furnace hoppers are carried away by a similar conveyor system, but before they are hoisted to suspended bunkers outside of the boiler room they are crushed to pass a ⅜-inch screen.

To illustrate the capacity of such coal-handling system for a single plant, that of the Rummelsburg plant, which is the smallest of the B. E. W. plants, is capable of handling 50 tons per hour.

The current generated at the various plants is three-phase, 6,000 volts, and is transmitted to sub-stations, as previously stated, where it is stepped down to 220 volts.

As the A. E. G. were always short in generating capacity, owing to the ever-increasing demand for current, storage batteries were installed on a large scale, being of 18,600-kilowatt capacity for a three-hour discharge.

In addition there are also large booster batteries with a total of 6,476 kilowatts for one-hour discharge.

During the year 1907, 200,768,000 kilowatt hours were produced, with a generating capacity of 104,236 kilowatts.

Credit is due to Mr. Ludwig Datterer, director of the Berliner Electricitäts Werke, whose data have been embodied herein.

THE DISTRIBUTION OF FOUNDRY TONNAGE BURDEN.

By F. L. Pinkham.

A commentary upon a paper bearing the same title, by Mr. Victor R. Claydon, published in our September issue, with Mr. Claydon's rejoinder.

MR. CLAYDON'S article in the September issue of THE ENGINEERING MAGAZINE states that the main opinions that have been expressed in the course of inquiry on the subject of tonnage-burden distribution are that the whole tonnage burden should be distributed to product on the basis of weight of:

1. Good castings *only* of each class produced.
2. Good and bad castings of each class produced.

There is no question that of the two bases the second will give results more nearly correct than the first, but there is a third basis which in my opinion will distribute this burden with greater accuracy, and that is:

3. Good and bad castings, gates and sprue of each class produced.

There will probably be some objection to the inclusion of gates and sprue, and it is conceded that if all three classes of castings produced the same percentage of gates and sprue, it would be wholly unnecessary to consider this item, but the fact is that the percentages of gates and sprue in the several classes differ greatly, and as labor, fuel, etc., have been expended in melting and carrying the material entering into them, there seems to be very good reason for having due regard to the weight of gates and sprue when distributing burden to the class of product which should bear the expense.

For the purpose of illustration we will use the same figures Mr. Claydon has and show his illustration "E" based on good and bad castings.

APPORTIONMENT OF TOTAL MELT.

Class	Pounds	Per cent of total	Amount	Per ton product
Boilers	415,245	83.07	$1,176.35	$6.34
Steam Fittings...	52,732	10.54	149.25	6.61
Jobbing	31,868	6.39	90.49	6.59
	499,845	100.00	$1,416.09	

A test of a month's work in the foundry would probably show about the following percentage of gates and sprue from each class of castings:

APPORTIONMENT OF GATES AND SPRUE.

Class	Per cent of each class	Subdivision of gates and sprue
Boilers	41	171,035
Steam Fittings	35	18,460
Jobbing	16	5,100
Total		194.595

By adding the above estimated weights of gates and sprue produced by each class of castings to the weight of good and bad castings, and using the sum as a basis for distributing the burden, we have:

DISTRIBUTION OF TONNAGE BURDEN ON GOOD AND BAD CASTINGS, GATES AND SPRUE.

Class	Pounds	Per cent of total	Amount	Per ton product
Boilers	586,280	84.43	$1,195.61	$6.45
Steam Fittings	71,192	10.25	145.14	6.43
Jobbing	36,968	5.32	75.34	5.49
	694,440	100.00	$1,416.09	

The effect of this method of distribution is particularly apparent in the cost of jobbing castings, which under the other plan have evidently borne an undue proportion of the burden.

By Victor R. Claydon.

In response to Mr. Pinkham's comment, I grant (as indeed I have already stated in other correspondence) that if one is in position to secure reliable information as to the actual quantity of sprues and gates of each class of castings produced, then doubtless it would be correct to include them in the apportionment of burden.

Naturally, this is a question which must be governed by the conditions existing in the foundry. In my own experience I have found that it would be practically impossible to obtain correct data on this point. In our own works, the moulders are not confined to the moulding of any particular class of castings, but one man may make all three classes; they also do their own pouring, so that you would

not get your moulders to separate their gates and sprues into distinctive classes.

Again, presuming that you are able to separate your gates and sprues so far: A moulder carries a ladle of iron to pour a number of moulds, and after pouring he finds that he has fifteen pounds of iron left in his ladle; this he throws out on the side of his floor. To what class of castings are you going to charge this iron, especially when the moulder has been working on several classes? In a cast of fifty tons these droppings reach a considerable weight and they would very materially affect the apportionment of percentages.

I take it that Mr. Pinkham's percentages of sprues and gates are fictitious, or assumed for illustration only, as there would not be nearly so great a difference between different classes of castings in ordinary practice.

It would appear to me that the labor entailed in separating the sprues and gates to their respective classes of castings would be too great to warrant the expense, as they would have to be sorted and taken to the cupola on separate trucks and weighed separately, necessitating an increase in the work and wages of the foundry laborers —in short, it would be an expense which would not be justified by its possible or probable fruits.

EDITORIAL COMMENT

The Value of the Aeroplane.

AS a scientific achievement, as a demonstration of cool nerve, or as an example of control of brain and muscle, cultivated to the point where it becomes instinctive, Wilbur Wright's flight up the Hudson on October 4 is memorable. But the leap by which popular imagination flies to the interpretation that this performance establishes commercial supremacy of the aeroplane is purely fantastic. Emotion has run away with reason.

Let us compare the fact with known standards of transportation already familiar. The vehicle in which one passenger made the aerial journey, and in which possibly two might have been carried, in over-all dimensions occupies probably nearly as much space as a passenger coach. Its weight in proportion to the live load it can transport is several times greater than that of a freight car. It needs as much room for safe manœuvering as a thousand-ton ship. Its power-plant is comparable with that of a touring automobile capable of equal speed, with six or eight passengers, or of a motor truck carrying comfortably three tons. Atmospheric conditions under which it can navigate at all occur scarcely oftener than one day in five—perhaps at a maximum one day in three. In case of mishap (except in unusual environment) it is more helpless than a ship without sea-room or anchorage. It is more fragile than a birch-bark canoe. It is dependent for its life at every moment on a mental and manual alertness of its operator comparable only to those of an expert juggler. And in safety to its occupants, a comparison with the tight rope or the flying trapeze is perhaps over-favorable to the aeroplane. If it is to outclass the railway and the steamship, as one enthusiast proclaimed, and supply the transportation of the future, it must advance a good deal in a good many directions.

But the enthusiast answers, of course: "Look at the Clermont! They scoffed at Fulton, too!" We are not scoffing; far from it. We are sincere admirers of Wright's achievement—all the more sincere for our acute appreciation of its difficulty—and probably we are as sanguine as he for the future. The Clermont, or steam navigation on the water, is simply not a parallel case. It would be more nearly parallel if the Clermont, instead of depending on power for propulsion only, had depended on her own power also for flotation, and at any stoppage of the engine had gone crashing to the bottom; if the Clermont, further, had had to navigate a stream which at any time might rush furiously in any direction, at twenty, forty, sixty miles an hour, with vicious cross eddies and swirls of far higher speed. As we once before suggested in these pages, the problem of navigating the air under conditions which may at any time surround the navigator is closely parallel to the problem of navigating the rapids of Niagara in a submarine, and will be about as easily solved.

Prof. Newcomb has pointed out that growth in size, which has done so much for the development of marine navigation, holds out little hope to aerial navigation. As the steamship is enlarged, its capacity for cargo carrying and for larger driving power increases as the cube, while the resistance it must overcome increases only as the square. With the aeroplane the ratio is reversed. Its surface spread, on which it depends for support, increases generally as the square, while its weight (which limits its power and load-carrying capacity) increases generally as the cube. And ocean

navigation, beginning with very crude machinery and construction, has progressed through the refinement of the steam engine and the refinement of structural material. That refinement has certainly progressed a long fraction of the possible way. It is scarcely conceivable that the aeroplane, beginning with so highly perfected motors and materials as are now available, can hope for any like margin of betterment which might radically change the unit factors of power, weight, and strength.

We do not query the interest or excellence of the Wrights' mechanical achievement. There is no reason apparently why they should not vastly better any recorded performance—fly thousands of feet high, or hundreds of miles in distance. Our skepticism is only as to the utilitarian value of any present or possible achievement of the aeroplane. We do not believe it will ever be a commercial vehicle at all. We do not believe it will find any very large place in the world of sport. We do not believe its military importance is as great as is commonly supposed, or will extend (except accidentally) beyond the range of scouting and courier service. Even here it remains wholly indeterminate how much (except mutual destruction) can actually be accomplished by men in flying machines, if other men in other flying machines are trying to prevent the accomplishment. And even the attempt must always be limited by the absolute dependence of aerial navigation upon weather conditions which in most places and in average seasons exist during only a minor fraction of the time.

Subsidized Shipping.

SHIP subsidies apparently are to be urged vigorously at Washington next winter, under the familiar argument of the crying need for an American merchant marine, and the representation that it can be obtained in this way and in no other. To the general proposition, not very influential with the public at large, or even with American shipping interests (which find at any moment more than an ample tonnage of cargo ships of other nations ready for all the freights America has to give) is now added a plausible plea drawn from the recent battleship cruise around the world. The navy, it is argued, would be helpless in war because it has been proved that the United States can not find enough American bottoms for its own colliers. We say "plausible," because a state of war, by closing much at least of the American coastwise trade, would thereby liberate for service with the fleet a large number of vessels not obtainable under the conditions of a peaceful cruise.

But whether or not this argument is well founded, we believe the deplorable fact to be that subsidies would be powerless to restore the American flag to any important place on the high seas, against the commercial disadvantages imposed on American ship owners by the results of protection and the restrictions of American navigation laws. The United States has coddled its internal industries to the destruction of the merchant marine. The policy proved highly profitable to the home manufacturer because the consumer was prevented by the tariff from dealing elsewhere; but it goes utterly to pieces when competition is open to the world, as it is and always will be in over-sea carrying. As long as American hulls and American registry make ocean freights under the Stars and Stripes necessarily greatly higher than freights under other flags, America can not command the sea. The attempt to equalize by taking the difference out of the shipper's other pocket in the form of a subsidy paid directly to the ship owner is utterly futile. Its advocacy is based on a false dependence on artificial foundations for natural industries—a dependence fostered by over-indulgence in the stimulant of protection.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

UNSOLVED PROBLEMS OF THE GAS ENGINE.

THE WORK OF THE BRITISH ASSOCIATION COMMITTEE ON GASEOUS EXPLOSIONS.

Dugald Clerk—British Association for the Advancement of Science.

AT the suggestion of Sir William White, the second report of the Gaseous Explosions Committee of the British Association for the Advancement of Science, presented at the recent Winnipeg meeting, was accompanied by a paper by Dugald Clerk pointing out the practical application of the knowledge acquired by investigation to the urgent present problems of the internal-combustion motor. As in the case of the steam engine, the internal combustion motor had attained a position of considerable development along lines of great practical utility before much knowledge was available of the properties of the working fluid employed. But further development, in many directions, Mr. Clerk says, depends on an intimate knowledge of these properties and of the phenomena of heating the working fluid by combustion. To obtain this knowledge the British Association Committee combines the work of physicists, chemists and engineers. Much of the investigation is of a purely abstract nature, but its immense practical significance will be apparent from Mr. Clerk's exposition of the lines along which future gas-engine development is likely to proceed.

A very large part of the work of the gas-engine inventor and designer has been devoted to the improvement of the thermal efficiency of the engine, with the result that it has risen from 16 to 37 per cent in twenty-six years. The improvement has been attained, broadly, by following the definite theory that thermal efficiency is increased by diminishing the volume of the combustion space relative to the volume swept by the piston. The possibility of further development can be determined only when a minute knowledge of the properties of the working fluid has been attained. Hitherto the guide adopted by engineers has been the air standard, which assumes the gas engine to perform its functions with pure air as its working fluid, to which certain definite physical properties and a constant specific heat are attributed. On these assumptions it is possible to calculate indicated thermal efficiencies for any given proportions of engine and compression space where loss of heat is supposed to be absent, and from comparison of efficiencies so calculated with those actually attained it has been sought to obtain some idea of the relative performances of different engines compared with a standard.

It has long been known, however, that the air standard, though exceedingly useful for comparative purposes, does not supply an absolute measure. For example, a comparison of the indicated thermal efficiency of an ordinary four-cycle engine, say, 35 per cent, with the ideal efficiency for the same engine using air as the working fluid without heat loss shows that the real engine con-

verts only 70 per cent of what would be converted by the ideal engine. If the properties of the two working fluids were identical, this result would indicate the possibility of a 30 per cent improvement if all heat losses could be eliminated. Clerk has shown, however, that even with elimination of all heat losses the actual working fluid of the engine could not be so efficient as air. His calculations, based on determinations of the properties of gaseous explosions by Mallard and Le Chatelier, Langen, Holborn and Henning, and Clerk, which differed from each other to some extent, demonstrate that with the actual working fluid such an engine as that indicated above really converts into work 88 per cent of all the heat which it could possibly convert, having regard to the properties of the mixture of gases forming it. If the adopted numbers are true, the suppression of all heat losses in a modern internal-combustion motor would result in an increase in the thermal efficiency only from 35 to nearly 40 per cent. It is, of course, impossible entirely to eliminate heat losses, and it would appear that the margin available for future improvement in thermal efficiency is small.

Calculations as to possible efficiency depend upon an accurate knowledge of the total energy of a mass of hot gas within a cylinder under different conditions, and necessitate an accurate knowledge of the temperature and apparent specific heat of the gases dealt with. Only when values of temperature and apparent specific heat are correctly determined will it be possible to define with accuracy the limits of efficiency proper to any cycle of operations. This knowledge it is the object of the British Association Gaseous Explosions Committee to supply. Experiments have been arranged in conjunction with the various investigators forming the Committee to enable correct determinations to be made and to eliminate satisfactorily the errors known to exist. The difficulties of the task will be apparent to anyone who examines the two reports of the Committee already published. The conflict between methods of determining the apparent and real specific heat of gases at high temperatures, all of them open to criticism, is still unsettled, though Clerk's recently developed method seems to be reasonably free from systematic error. The problem of temperature determination, though subsidiary, involves difficult investigations by chemists, physicists, and engineers on the questions of chemical equilibrium, dissociation and thermal distribution. Progress, though slow, has been certain, and it is confidently felt that by continued experiment and discussion close approximations to true values will ultimately be obtained.

"Even with our present knowledge, however, it is becoming increasingly evident that certain limits are close upon us, and that further increases in indicated thermal efficiency will be possible only by considerable alterations in the actual thermal cycle used, and that little further development is possible on the old lines of increasing compression. To decide, however, which is the direction of advance, it is necessary to know very accurately both temperature and specific heat, as I have indicated.

"Maximum temperatures of 1,700 degrees C. are usual in economical internal-combustion motors, and a perfect heat engine taking in all its heat at that temperature, and discharging only that necessary on the Carnot cycle at 17 degrees C., would give a thermal efficiency of 85 per cent. The highest actual efficiency obtained so far is about 37 per cent, and this is about 87 per cent of what its perfect cycle would allow. This is obviously far short of the Carnot cycle efficiency, and it appears possible that actual efficiencies as high as 50 per cent may be obtained by modifying the existing cycle in order to attain greatly increased expansions by compounding and condensing. The use of the regenerator may even become possible in large engines operating on changed cycles.

"Although further improvement in thermal efficiency is of high scientific interest, for the present the efficiencies already attained are sufficiently good; and, indeed, they may be considered as having over-run the existing stage of development of the large gas engine considered as a mechanism; that is, large

engines require attention more on the mechanical than on the thermodynamic side. The work of the Committee is of the utmost importance in this connection.

"Commercial gas engines are usually designed to take safely a regular maximum pressure of 400 pounds per square inch, but in the event of pre-ignition they may have to stand 500 pounds or even more. In an engine so designed the working mean pressure will not usually exceed 80 pounds per square inch. The maximum pressure in the engine cylinder is usually about five times the mean pressure. In engines of moderate dimensions, giving, say, up to 200 indicated horse power per single-acting cylinder, it is not very difficult to comply with all the mechanical conditions necessary for safety and continuous working under heavy loads. The case is very different, however, in gas engines of really large dimensions. The largest power claimed as produced in a single double-acting four-cycle cylinder at present is about 1,200 horse, and the cylinder is about 45 inches in diameter, stroke 51 inches and revolutions 94 per minute. To construct an engine with so large a cylinder, and get it to operate with freedom from breakdown, taxes to the utmost the resources of the skilled designer and constructor. Great credit is due to those persevering Continental, English, and American gas engine designers who have devoted so much time, skill, and money to overcoming the difficulties of these large constructions. Although a certain measure of success has been attained, yet it is success with important limitations. I cannot help feeling that before any permanent financially successful development of the large-cylinder gas engine can be hoped for—such a development, for example, as would permit an engine of 10,000 horse power to be applied to marine purposes—it will be necessary to do more than skilfully meet the various difficulties in a mechanical way. It will be necessary, in fact, to re-design the thermodynamic cycle of the large gas engine in order to obtain a closer approximation to the easier mechanical conditions of the large steam engine. The conditions of the steam engine are very much less onerous than those of the gas engine. In the matter of mean pressures, for example, no marine steam engine exists where the ratio of maximum to mean pressure in any one cylinder is so high as 5 to 1. The temperature conditions, too, of the steam engine are much more gentle. It is quite possible to re-design the gas engine cycle in such a way that maximum pressures do not exceed, say, 150 pounds per square inch, while mean pressures of 70 pounds per square inch are obtained. It is also possible to diminish the flame temperature used within the cylinder to such an extent as greatly to reduce the heat flow through the cylinder walls. To do this, however, and produce, say, a 10,000 horse-power marine gas engine, it is necessary to know with considerable accuracy the rate of heat flow from hot gases at certain temperatures—say, between 2,000 degrees C. and 800 degrees C.—that is, the rate of heat flow from those gases to the enclosing cylinder walls. It is also necessary to know how that flow is affected by variations in the density of the gas. Further, it is necessary in designing such large engines to discover some method of entirely suppressing pre-ignitions. Consider the position of an engineer working out the design for a large marine steam engine, say, if he be told that his ordinary maximum pressure, as supplied by the steam boiler, is 150 pounds per square inch, but he must so design his engine that if 300 pounds, or even 400 pounds, per square inch perchance comes upon it, then it must not break down under that added stress. It would be hardly possible to design a large steam engine with such a condition overhanging him.

"Part of the work of the Committee consists in determining the conditions of heat flow to the cylinder walls, the amount of that heat flow under certain conditions at various densities and at various temperatures. Given this knowledge, it will become possible to design engine cycles whose mechanical conditions are much less rigorous than those existing in the large gas engine of to-day. Such a cycle must have low maxi-

mum pressure, relatively high mean pressure, low mean temperature, and as low density of working fluid as is compatible with economy at certain portions of the thermodynamic cycle. So far only approximate values are known, but continued investigation will undoubtedly enable a sufficient accuracy to be attained. To enable high temperature determinations to be made it was found necessary to reconsider much of the low-temperature work, and even Regnault's determinations of, for example the specific heat of air, were found to be erroneous to the extent of 2 per cent. Two per cent error at low temperatures is not of any great moment from the engineering point of view, but it introduces much larger errors when high temperatures are studied; so that even the low-temperature work must be revised. Other physical problems arise which require consideration. The problem of radiation from a gaseous explosion, for example, is one which has a considerable bearing upon the mechanical conditions at the high-temperature end of the thermodynamic cycle. Other physical problems are being dealt with, such as the heat distribution throughout the walls of the combustion space, the valves, and the piston end. The conditions of chemical equilibrium within a gaseous explosion are also of moment from the practical point of view, and chemists are rendering valuable aid in co-operation with the physicists to determine what really goes on at the explosion end of the engine cycle.

"Existing large gas engines are disproportionately heavy and bulky for the power developed by them, and increase of power with reduction of weight can only be attained by compromise between conflicting conditions. The gas-engine designer cannot even consider the points of difference without minute knowledge of the conditions of heat flow to the walls and heat distribution in them. This knowledge the Committee hope to be able to acquire, for the benefit of both abstract and applied science."

A SIMPLE IDENTIFICATION TEST FOR IRON AND STEEL.

THE THEORY AND APPLICATIONS OF THE SPARK TEST AS A BASIS FOR THE CLASSIFICATION OF MATERIALS OF VARIOUS COMPOSITIONS.

Max Bermann—International Association for Testing Materials.

THE phenomenon of the production of sparks in the grinding of iron materials by means of emery wheels is a familiar one. Depending on the size and shape of the metal and the pressure between the metal and the wheel, the sharp edges of the emery crystals detach chips of different sizes at a very high velocity, which are raised to a red heat by the transformation of mechanical into heat energy. The path described by the glowing chip from its origin to its extinction forms a line of light, which may be called the spark ray, of variable length depending on the mass of the spark. The size of the spark in turn depends on the grain of the emery, the cutting speed, the nature of the metal, and the pressure between metal and wheel. The initial temperature of the spark is influenced principally by the cutting power and cutting speed of the emery wheel, and in a minor degree by the nature of the metal to be ground.

It has remained for Herr Max Bermann, a Budapest engineer, to observe that the sparks produced in grinding iron materials possess uniformly characteristic differences, which depend upon the percentage of carbon present and the inclusion of alloy materials in the metal. He suggests the spark test as a simple means of classifying iron and steel products of various compositions, and has evolved a theory of spark formation which seems to raise his suggestion above the plane of mere speculation. From a paper read at the recent Copenhagen congress of the International Association for Testing Materials, reprinted in *The Iron Age* for September 23, we take a few notes of the characteristics of

sparks of various steels, an outline of Herr Bermann's theory, and his suggestions of possible applications of the test.

Examination of one of the longer spark rays of a soft steel, or wrought iron, shows a quite fair line of light, at the end of which is an extended drop, pointed in the direction of flight. The heat of this drop formation varies between a bright red and a white glow; close observation shows that its pointed dark red end is extended to form a second much smaller drop. At the broadest point of the first drop formation, where it is of a white heat, pointed, prickle-like lines run out of it in all directions with almost explosive violence. The pointed branching lines, have, in the lateral projection, a forked appearance, while in the direction of their flight they look as if rushing from a very brightly glancing knot shooting forward in an explosion-like manner and disappearing in a moment.

This explosion-like appearance and articulation of the spark ray, to which the name "spark picture" is given, is different for different kinds of iron, and is, in fact, characteristic for each. For all carbon steels the spark picture is a tuft of prickle-like lines. Steel with 0.07 to 0.08 per cent carbon shows two or three lines which appear to start from different points of the shining drop. The number of branching lines increases with the percentage of carbon. At 0.25 to 0.28 per cent, a crowd of lines appear to spring from a common point of the drop, and with still larger percentages the lines are proportionately more closely crowded over a larger part of the drop. The spark picture of crucible cast steel resembles the branch of a blossom and the individual branching lines have a lilac-like form.

From the number of prickle lines in the spark formation, therefore, the percentage of carbon in steel can be estimated and the different kinds of steel distinguished. The addition of other elements to the steel introduces variations in the spark from which the various alloy steels can be no less easily recognized. The presence of manganese is especially easy of detection. In the spark picture of manganese steel the individual branching lines are no longer pointed but in each case show a second explosion-like phenomenon, shorter lines collecting, like leaves around a central point. The extent and shape of the spreading ends of the primary branching lines appear to stand in connection with the percentage of manganese in the steel, the number of primary lines still indicating the carbon content. In the case of tungsten steel, the spark rays are dark-red, hatch-stroked lines which show little tendency to produce a spark picture until the steel is pressed hard against the emery. When the pressure is sufficient, the drop formation appears at the end of the spark rays and out of it spring the branching lines; in this case, the ends are neither pointed nor leafy, but take the forms of little shining balls which seem to be projected out of the drop, the branch lines being scarcely visible. The combination of spark rays and spark picture of chrome-tungsten steels is characterized by two kinds of ray, very thin dark red and thicker brick red, which are absent in the case of simple tungsten steel. The spark picture of these high-speed steels consists solely of short curved drop formations; the long needle-shaped lines with clubbed ends which sometimes appear may be taken to indicate the presence of a subsidiary alloy metal. Nickel steel shows a spark picture similar to that of carbon steel, but without the regularity of the latter. The sporadic manner in which the spark picture appears is the distinguishing characteristic of the spark test for nickel steel. The spark pictures of the various kinds of cast iron are as easily distinguished as those of the various steels.

Herr Bermann's theory of the spark phenomena is based on two facts of which his observations have given ample proof. These are: "(1) at a certain point in its line of flight the red hot spark assumes a yellow heat; it then reaches a white heat, thereby transforming itself in an explosion-like manner into the spark picture; (2) at the moment of its explosion-like transformation the spark is in a fluid state. The

increase of heat of the spark (where an extinction due to rapid cooling would more reasonably have been expected) is caused by an internal source of heat, represented on the one hand by the transformation heat of the amalgamated carbon at the critical temperature produced by cooling, and on the other by the combustion heat of the transformed carbon which in the *status nascens* suddenly burns. The heat of oxidation of the exterior surface of the mass of sparks acts in opposition to the too rapid cooling of the spark. The quantity of oxygen necessary for the combustion of the carbon is now supplied by the crust of black oxide of iron which, up to the point of critical temperature, has been formed.

"The heat of combustion of the carbon constituent provides the quantity of heat necessary for the fusion of the mass of sparks. As a matter of fact, however, this heat is not sufficient to melt the whole mass, because the amount of carbon is too small. A melting of the spark takes place when the mass of the unoxidized core within the oxidized iron crust is small enough to be melted by the quantity of heat available. In this case the combustion gases of the amalgamated carbon burst the outer crust of the spark mass and thrust out the fluid contents in the direction of the primary branching lines. The silicon and phosphorus therein contained also burn at the melting heat of the iron and raise the temperature of the fluid mass. From this explanation it follows that the size of the fusible spark increases with the percentage of amalgamated carbon, while the quantity of the fluid core and the tension of the combustion gases are correspondingly greater and the branching lines more numerous.

"The practical applicability of the spark test is manifold. The most important instances of it may be shortly given as follows:

"1. The classification of the different kinds of iron in accordance with 'percentage of carbon' and 'principal alloy metal.' The ends of rods which may eventually have been wrongly arranged in the storing rooms of the iron working industries are made to bear against the revolving emery wheel. The shape of the spark picture gives unerring indication of the kind of iron to which the rod in question belongs. Pointed branching lines in the spark picture denote carbon steel—*e. g.,* Siemens-Martin steel: leafy ends of the branching lines a manganic steel (Siemens-Martin steel with larger percentage of carbon). Spark pictures with a blossom branchlike arrangement indicate ordinary tool steel; dark red stroked spark rays and shining points and little balls thrown out of the drop formation, tungsten steel; two different kinds of spark rays of dark red and brick red color, respectively, with short unarticulated drop formation, high speed steel with chrome and wolfram as alloy elements; when explosion-like articulation is present, a secondary alloy metal (molybdenum, vanadium or titanium) is in question.

"2. The spark test is so sensitive that it gives strikingly clear indication of a difference of 0.01 per cent of carbon, and it accordingly offers a very simple and rapid check on the chemical analysis in regard to the amalgamated carbon in steel, and also forms a suitable check on the Siemens-Martin process (in place of the forge test), particularly when analyzed standards are made use of for comparison. The assay sample is chilled and the sparks compared with those of the standard. The carbon in the charge is then increased or lessened, according to the differences which show themselves.

"3. In the purchase of different kinds of iron the spark test supplies a sure means of excluding material which does not comply with the conditions. When a suitable sample is available, it is only necessary for the testing official to satisfy himself of its identity with the material offered by comparison of the spark pictures. The material for quality tests is chosen from charges which give spark pictures identical with those of the samples, and from those of which the spark pictures show considerable difference. At the test these latter will show themselves as not in accordance with the conditions.

"4. The spark test supplies a very sensitive means of establishing with certainty any differences there may be in the chemical composition at different points in the iron product, and also in finished objects and structural parts.

"5. The spark sheaf and the spark pictures provide the possibility of at once determining whether a cast iron is gray or white, and also of distinguishing shades of difference in the individual varieties. Fine dark red spark rays, spark pictures here and there, and lines collecting round the drop formation like a net, formed by the leaf-like articulation lines, denote black or very dark gray cast iron; spark pictures corresponding with manganic steel, gray cast iron. The netlike lines retreat more and more with the increase of the assimilated carbon, and with light gray cast iron they disappear altogether.

"6. In shop work the spark test, when once introduced, is not easily done without. In the hardening room counsel is taken with the spark prior to the hardening of the tools (which are to-day made of steel of the most varied kinds), to avoid the occurrence of gross mistakes in the hardening temperature applied. The wire for the manufacture of different spiral springs is likewise examined with the emery wheel, to see whether it has the degree of hardness and other properties suitable to the purpose in view.

"In the forge the spark is applied to the distinction of good malleable wrought iron from such as is difficult to weld, etc."

PROBLEMS OF ROAD ADMINISTRATION.

A PLEA FOR CENTRALIZED CONTROL OF HIGHWAY CONSTRUCTION AND MAINTENANCE IN THE UNITED STATES.

Logan Waller Page—The Engineering Record.

THE last twenty years have been marked by continued and substantial progress in highway construction and administration in the United States, but Mr. Logan Waller Page, Director of the United States Office of Public Roads, in a recent paper before the National Roads Congress, presents ample evidence to show that the United States is still far behind European countries both in administrative organization and in provision for road maintenance. Imperative needs, he says, are the provision of more money for roads, a definite system of maintenance, and centralized skilled supervision. The conclusions he draws from European practice are briefly outlined in the following abstract of his paper as reprinted in *The Engineering Record* for October 2.

According to a careful road census, the total road mileage in the United States amounts to 2,155,000. By the most liberal estimate the expenditure in both money and labor in this mileage is at the present time about $90,000,000 per year. England spends on her 150,000 miles of roads about $80,000,000 per year, or about 14 times as much per mile as the United States. The United States road census shows about 2 per cent of the total mileage (40,000 miles) to be stone-surfaced, and about 5 per cent (108,000 miles) to be gravel road. Though the annual expenditure on roads is small the total expenditure in the 30 years 1870 to 1900 amounted to over $1,800,000,000. Nevertheless, considering area, population and wealth, road building in the United States is in the same condition as it was 30 years ago, and the large total expenditure on roads has produced few appreciable results.

The system of road administration in about half the States is practically the same as that which prevailed in England when America was a colony, the wasteful and ineffective system which provides for payment of road taxes partly in labor, localizes the work to an extreme degree, and places the supervision of road construction and maintenance in

the hands of petty officials with no skill in, or knowledge of, road building. It is only within the last twenty years that road administration has been placed on a sound and practical basis in the other States which have adopted in principle or practice, or both, the system of centralizing the conduct of the road work of the State under State Highway Departments. The progressive States comprise the New England States, New York, Pennsylvania, New Jersey, Delaware, Maryland, the Virginias, Ohio, Michigan, Illinois, Wisconsin, Minnesota, Missouri, Kansas, California, and Washington. These have expended within the last few years over $56,000,000 of State funds on road construction and administration.

The advantages of centralized control can be plainly seen from a consideration of the results of the administrative systems in foreign countries. In France skilled supervision is provided in every grade of road work and in every unit of the administration. The roads are classified for administrative purposes into four classes: national routes, traversing various departments and connecting important centres of population; department routes, connecting important centres of a single department; highways of grand communication, little less important than the department routes; and highways of public interest, traversing single cantons and acting as connecting links for the more important roads. There are 23,656 miles of national routès which cost $303,975,000, and 316,898 miles of local highways constructed at a cost of $308,800,000, of which the state furnished $81,060,000.

The road mileage in England is 149,759; the expenditure in 1905-6 amounted to $78,059,000, about $520 per mile. This large annual expenditure is devoted in large measure to maintenance. The high cost per mile would seem to indicate a wasteful and inefficient system. It may be explained, perhaps, by the fact that in England road administration devolves entirely on local authorities, although State aid is given. The system of municipal government in England is exceedingly complex, and this complexity prevents centralization of control, so long as road administration is left in the hands of local authorities. Skilled supervision is not required by law but is usually provided by the highway authorities.

In Germany road administration is conducted separately by each State of the Empire. In Saxony, to take a typical example, there are State roads, built and maintained by the State, and communicating roads, built and maintained at the expense of the parishes through which they pass. The State roads are cared for by a commission of engineers, and the technical supervision of all the roads is exercised by competent State officials. In Switzerland also road administration is in the hands of technically trained men.

Mr. Page infers from the results of the systems of these four countries, all of which provide some degree of skilled supervision and ample cash resources, that centralization makes for economy and efficiency in the administration of public roads. In England, the most striking example of extreme localization, lack of uniformity in road work and excessive expenditure in proportion to mileage are most pronounced. France, whose road system is the most perfect in existence and whose system is most highly centralized, expends about the same amount as England on 2 1-3 times the mileage. It is to road maintenance in the United States, however, that Mr. Page wishes to direct special attention. Roads are now being constructed at great cost which compare favorably with the best roads of Europe; it is of the highest importance that adequate provision should be made for their maintenance. In 1901 the cost of road maintenance in England and Wales was $370.34 per mile; in 1907 it was $446.74 per mile, an increase of about 20 per cent. In France the cost of maintenance increased in the same time about 5 per cent; in 1904 it was $243.33 per mile. The cost in Germany in 1906 was $214.13 per mile, and the cost in Belgium $277 per mile.

These figures emphasize two facts, that even the best of improved highways

are not self-sustaining, and that the cost of maintenance varies tremendously with the degree of centralization of the administrative organization which has the roads in charge. Judging from the experience of European countries, parsimony in the provision of money for road maintenance in the United States will result disastrously in two ways; first, granted that the roads are not allowed to go entirely to ruin, the cost of maintenance will be higher the more local and loosely centralized the organization for maintenance; and second, systems of intermittent maintenance are sure to increase in cost from year to year as they have in Europe. Road revenues in the United States are entirely inadequate. The expenditure of $38 per mile is expected to cover new construction, bridge building and all classes of maintenance. The imperative needs of the United States are more money for roads, definite provision for maintenance, a system of continuous repair, and a centralized skilled supervision.

PHOTOGRAPHIC METHODS IN TOPOGRAPHIC SURVEYING.

THE METHODS OF THE CANADIAN GOVERNMENT SURVEY FOR THE DELINEATION OF THE ALASKAN BOUNDARY.

P. W. Greene—Canadian Society of Civil Engineers.

PHOTOTOPOGRAPHY, the method of constructing topographic maps which consists of photographing the country from prominent points and then plotting the data so obtained in the office, since its successful introduction in the Rocky Mountain survey inaugurated in 1888, has been more extensively and practically applied in Canada than in any other country. In 1893 the method was employed in making a topographical reconnaissance for the delineation of the Canada-Alaska boundary in Southeastern Alaska, and since then it has been used exclusively on this work. The following brief notes on Canadian practice in phototopography is taken from a recent paper by P. W. Greene before the Canadian Society of Civil Engineers.

The instruments employed on the Alaskan boundary survey are two, the camera and the transit. On account of the nature of the country and the climatic conditions encountered, both are necessarily of the simplest possible design. The camera consists of an outer mahogany box, inside of which is a second box carrying the lens, which can be moved backward or forward by means of a milled screw attached to the outer box. The plate holder fits into the latter. In operation, the inner box is moved back so as to come in contact with the plate holder, that end of the inner box, of course, being open, and the camera, having a constant focal length, is then focused and ready for exposure. The Zeiss anastigmatic lens used has a focal length of about 5.5 inches. An orange ray filter is employed to give sharp definition of distant objects, particularly mountain peaks. It has the additional advantage that it lengthens, and so makes easier to judge, the required exposure. Exposures are made by passing a slide in front of the lens by hand.

Two sets of cross-level bubbles, one on the side and one on the top of the camera, are provided, so that the apparatus can be used either horizontally or vertically. Instead of the ordinary type of finder, three small nail heads arranged triangularly on the top of the camera, with the vertex at the back, enable the operator to ascertain the field. The camera rests on a triangular base, identical with the base of the transit, so that both may fit the same tripod. The camera outfit complete, including case, seven plate holders, and fourteen plates, weighs about 19 pounds. The transit used is a very light three-inch instrument, reading to single minutes. The light, folding tripod, only 3 feet 4 inches long when extended, the transit, and case, weigh only 14 pounds. The only instrumental adjustment of the camera

necessary is the adjustment of the level bubbles so that when the camera is level the plate will be perpendicular. Compared with most European instruments, the whole equipment is very simple.

A photographic survey is carried on necessarily in connection with a triangulation scheme, by means of which the positions of the camera stations are determined. The triangulation stations are so chosen as to form good camera stations. The qualifications of a satisfactory camera station are: (1) a good view of the surrounding country, unblocked by close or higher peaks; (2) that photographs taken from it shall contain points seen from other stations; and (3) that the intersection on any points to be plotted from two camera stations shall not be too acute. A judicious selection of suitable stations, to avoid both duplications and omissions, is the most difficult part of phototopographic work and requires a thorough understanding of the methods of plotting and also of the practical difficulties met with in the field.

"A full climbing party usually consists of five men. On reaching the summit of a peak the observer and recorder immediately start on the camera work, while the men busy themselves gathering rocks for the cairn which supports the triangulation signal. The camera is levelled up as an ordinary transit, and after focusing is ready for exposure. A series of seven photographs is taken, including the complete round of the horizon, each photograph slightly overlapping the last. The points to keep in mind are that the camera shall always be focused as described and that it shall be level before exposing. The exposures vary from 10 to 60 seconds. A sharp peak or any well defined point is chosen in the field of each photograph, and this is sketched and briefly described by the recorder. He also records the exposure and the plate exposed.

"Frequently duplicate photographs are taken in certain directions and developed in camp. These give valuable assistance in the choice of future stations and also serve to indicate if the camera is working satisfactorily. When the photographic work is finished the transit is set up in the same place and the points mentioned above are tied in to some peak or station of known position, and thus the azimuth of all points in each photograph is known. By means of the sketches and descriptions, the points may be easily recognized on the photographs." The small transit is used only to tie in the camera stations. The triangulation angles are taken after the photographic work is completed, by means of a larger instrument and by accurate methods. When the triangulation signal is put up, the party is ready to descend. The most satisfactory signals are made of sheet iron in two-foot lengths, which are fitted together to a total length of ten to twelve feet. To this standard a large black and white flag is attached and the whole signal is erected as securely as possible in a cairn of stones. The time required to occupy a peak is about three hours.

Isochromatic medium plates, made by Edwards, London, are used on the Canadian survey. The whole season's supply is taken out in the spring and every possible precaution is taken for their preservation. With the exception of the duplicates already mentioned all plates are developed in Ottawa, at the Dominion Observatory. For purposes of plotting, double enlargements are made on bromide paper; the final prints are about 10 by 14 inches and are used unmounted.

In the Canadian work all plotting is done by the original observer. Contour maps are made showing 250-foot contours. The number of points plotted to the square mile depends on the accuracy required, the topography of the space between the points being sketched in from the photographs. The method of plotting is as simple as the field work. The first operation is to draw the "horizon" and "principal" lines on the prints. The former is so located that all points having a greater elevation than the camera station will show above it, and all lower points below. The principal line is drawn vertically through points in the centre of the field of the camera. The location of these lines is indicated

on the print by V-shaped projecting points, which result from carefully adjusted projecting teeth in the interior of the camera near the plate.

The plotting of the photographic records follows the plotting of the triangulation scheme. As has been noted, in taking the photographs from the stations of the triangulation survey certain known points in their fields are located by transit bearings. From these bearings, the bearing of the principal line of each photograph may be laid down from the point on the triangulation map. Along the bearing of the principal line, the focal length of the camera is laid off, and through the point so obtained a perpendicular is drawn. The position of any point in the photograph may then be plotted as follows: the distance of the point on the print to right or left of the principal line is transferred by proportional dividers, set according to the scale of enlargement of the original photograph, along the right or left of the perpendicular to the bearing of the principal line on the paper, from the intersection of the two. A line joining the point so obtained with the principal triangulation point gives the bearing of the point whose position is to be plotted. The operation is repeated for the same point as shown on another photograph taken from another station, and the intersection of the two bearings gives the exact location of the point on the map. The angle of elevation or depression of the point above or below the camera station is obtained from a graphical scale plotted from calculations on distances on the prints and the focal length, and from this angle and the horizontal distance scaled from the map, the difference of elevation, and hence, the altitude, of the point is obtained.

In the Alaskan boundary survey the average climbs range from 4,000 to 7,000 feet. Both ascent and descent are made in one day. The climate in Southeastern Alaska is unfavorable for this kind of work, and there are, as a rule, only from 20 to 40 suitable days for work in a season. During a season a party will occupy from 15 to 30 stations, commanding an area of topography of from 500 to 1,500 square miles. The cost varies largely in different localities. Delville, the Surveyor-General of Canada, gives the cost of the Rocky Mountain survey of 1894, when the method was not so far advanced as now, as $7.50 per square mile. In this survey 15 to 20 points were plotted to the square mile. Delville's comparative figures prove undoubtedly that in mountainous countries no other method can compare favorably with the photographic method in economy.

ARTESIAN WATER SUPPLIES.

A REVIEW OF THE PROGRESS OF ARTESIAN WELL WORK IN DRY COUNTRIES.

Engineering.

IRRIGATION projects involving the diversion and control of large streams, such as the scheme described on another page of this number of THE ENGINEERING MAGAZINE, have been undertaken on such a tremendous scale in various parts of the world within recent years that the less spectacular development of artesian water supplies for irrigation has progressed with comparatively little notice. A review of progress in *Engineering* for September 24, however, shows that the reclamation of arid regions by the utilization of ground waters has been conspicuously successful in the United States and Australia, and that the prospects of similar success in Cape Colony, Algeria, Egypt and other less developed countries are exceedingly promising.

"As to the United States, the immediate vicinity of the Rocky Mountains from north to south on the eastern side of the range forms such a continuous series of artesian basins that they might be almost regarded as one. These extend from Montana through Wyoming, Colorado, New Mexico to Texas, and to

North and South Dakota, Nebraska, Missouri, Arkansas, Iowa, and Kansas. Besides these, there are many smaller artesian areas, comparatively speaking, in Idaho, Utah, Nevada, California and Arizona to the west, and eastward in Indiana, Ohio, Illinois, Kentucky, Mississippi, Georgia, Alabama, Florida, and other States. In these latter, however, a fairly plentiful rainfall diminishes the value of wells in comparison with those of the arid regions at the base, east and west of the Rockies. To provide for the requirements of cattle, irrigation, and town water supply, the latest reports show that there are considerably over 17,000 bores west of the 97 degree meridian. In the small area surrounding Denver alone there are nearly 350, while in the comparatively limited extent of the San Luis Park, in Colorado, nearly 4,000 wells have been put down within an area of 8,000 square miles. This is in a sort of pocket hemmed in between the Sangre de Christos Mountains and the main range of the Rockies. The whole country to the south between the Rio Grande and Brazos River is dotted with successful bores, and west of the longitude of Austin there are over 1,000 wells. At numerous places through this territory magnificent flows of water have been secured, and what was some years ago almost a desert is now well supplied with water for towns and villages in sufficient quantities to render possible the introduction of new industries, besides providing supplies for cattle and for irrigating many thousands of acres for agriculture. The wells vary in depth from 50 to over 3,000 feet, and the supply in most cases is copious. The industrial uses to which this water is put are many. At Waco on the Brazos River, hundreds of sewing-machines in clothing factories, electric plant, wood-working machinery and other small industries, are run by the pressure of the wells, without wasting the water, which is also used for irrigation.

"Coming east, we find the towns of Savannah, Charleston, Jacksonville, St. Augustine, Key West, Memphis, Galveston, Fort Worth and others in Florida, Mississippi, and Texas, supplied with water from underground sources under pressure.

"The great majority of the bores in the United States are not of excessive depth, and, consequently, the water obtained is of moderate temperature; but there is one at Putnam Heights, in Connecticut, where a depth of 6,004 feet has been reached—one of the deepest in the world. As to pressure, the Dakota wells seem to hold the first place, for in two cases pressure runs up to 200 pounds per square inch.

"Turning to Australia, apart from the comparatively unimportant area on the Western Coast of Western Australia between the Darling Range and the ocean, the main water basin of the Continent, considered as an undivided and definite whole, is the largest yet discovered. It is in the form of a very irregular equilateral triangle with a long narrow tongue extending towards the north from its northern apex. The apex is between Cloncurry and Woolgar, in Queensland, the eastern end of the base being near Dubbo, in New South Wales, and the western about latitude 28 degrees and east longitude 133 degrees in South Australia, while the tongue occupies the western watershed of the Peninsula of Cape York. The area is about 570,000 square miles. As the western and southern boundaries of the triangle are almost completely in dry country, the intake beds are mostly on the eastern side, and are more or less identical with the great coast range which extends the whole length of the eastern side of the Continent, roughly parallel to the Pacific coast, and distant from it about 100 to 200 miles. The intake area has been estimated at 68,000 square miles. Like most of the artesian basins of the world, it is not perfect, without other outlets than those provided by the bore-holes.

"There has been no estimate made of the quantity of underground water lying in the whole of the beds tapped by the wells, but Professor David, of Sydney University, has shown that, as regards New South Wales, which possesses only one-seventh of the total area, at least 56 cubic miles of water are stored. This is based on certain estimates of the thick-

ness of the porous beds, 600 feet near the intake and 100 to 200 feet to the west, and on the assumption that they will absorb at least 12½ per cent. of water. Even if a fraction of this quantity be liberated by bores, great results may be expected, not only in providing water for sheep, but also for irrigation purposes, for it has been recently shown that a large portion of this arid country, formerly thought to be only fit for sheep, is quite suitable for agriculture if sufficiently watered.

"As to the Queensland portion of the area, the Bimerah bore, 5,046 feet deep, is believed to be the deepest in Australia. It yields 70,000 gallons daily. The total number of bores in this State, public and private, is about double that of New South Wales, or 973; these have cost about 1,500,000*l*. Their aggregate depth is over 225 miles, and the total flow about 1,450 acre-feet daily. The largest flow from any one well is that at Charleville —3,000,000 gallons daily. There are nine towns in Queensland supplied by artesian water. Most of the large area of South Australia included in the great basin is in unexplored territory, and the work done so far is, therefore, insignificant. From this summary it will be seen that Australia is far behind the United States in making use of her artesian supplies."

Geologically, Cape Colony is favorably circumstanced as regards underground supplies, although as far as can be judged in the present early stage of artesian work, the prospect is not so promising as in Australia. According to the latest information over 9,000 bores have been sunk in the Cape Colony, generally one-half the cost, with a limit of 8s. per foot, being granted by the Government, the landholder paying the balance. To a large extent the water is obtained from underground tanks formed by dykes of igneous rocks which traverse the water-bearing beds in all directions. The greater proportion of the bores in these areas are sub-artesian, partial pumping being required. In the older rocks of the south and west of the Colony, there would appear to be water stored in the trough-like folds due to earth movements, lying at greater depths; but before much is done there the local geological features must be better known in detail than is the case at present.

Artesian wells have been known in Algeria for centuries. As far back as 1856 a well was sunk in the Oued Rirh, a district of the Sahara, which yielded the large quantity of 1,278,000 gallons daily. Over twenty years ago the yield from all the wells was over 80,000,000 gallons daily. This amount has been greatly added to in recent years, so that it is said that over 18,000 square miles are now served, and the great industry of date palm and other fruit growing has been enormously developed. In Egypt much is being done by the Western Oases Company and the Kharga Reclamation Company. Though many of the wells, which are chiefly of the sub-artesian kind, are many hundreds of miles from the Nile, the general belief is that this river is the source of the supply.

"Not only is there still plentiful scope for artesian work in the dry countries mentioned above, but there are others practically untouched, as yet, where deserts may be turned into gardens by this simple means. Parts of Mexico, Chili, and Peru may be cited as examples. In the latter there are considerable stretches of country between the Andes and the Pacific, corresponding to the similarly-situated 'dry belt' of North America, which would probably be more easily served by the Andean rains coming through natural underground conduits, and wells under pressure, than by dams and canals. Lake Titicaca, 12,500 feet above sea-level, 160 miles long, 60 miles wide, and said to be 900 feet deep, has no visible outlet to the Pacific or Atlantic, and is known to drain underground through permeable formations to the former ocean. Lake Poopo is almost a similar case.

"Considering that, in an average instance in the Australian basin, with high-priced labour, a 2,670 feet bore, with over forty miles of distributing channels, costing 3,374*l*., produced a gross return of 11 per cent. on the outlay, a fairly optimistic view may be taken of judiciously-selected artesian work in the drier parts of the world."

THERMO-ELECTRIC MEASUREMENT OF STRESSES.

A METHOD OF DETERMINING ELASTIC STRESSES AND ELASTIC LIMITS OF METALS BY THERMO-ELECTRIC MEASUREMENTS.

E. Rasch—International Association for Testing Materials.

THE sensitiveness of the thermo-electric couple to slight temperature changes has been utilized by the German Royal Testing Laboratory for the curious purpose of determining elastic stresses and the elastic limits of metals. According to a paper by Herr E. Rasch, read at the recent Copenhagen meeting of the International Association for Testing Materials, a thoroughly practical method of stress determination by means of thermo-electric measurements has been devised and has been employed with success in the Laboratory. From *The Engineering Record* of October 9 we take a brief abstract of Herr Rasch's theoretical explanation.

When an elastically stretched rod of metal, of length $L = 1$, and cross-section $F = 1$, undergoes under a force p at the absolute temperature T a purely elastic elongation, then the rod will cool by:

$$-\Delta T = \frac{T\alpha}{m\delta}\Delta p \text{ degrees,}$$

where α is the thermal coefficient of expansion, δ is the specific heat of the material, expressed in mechanical terms, and m the density of the material. The test rod will, until true equilibrium is established, take up a quantity of heat ΔQ, which is withdrawn from its warmer surroundings. Conversely, when the load is removed, the body will heat and will transmit heat to its surroundings by radiation and conduction.

We therefore have to deal with a reversible Carnot cycle. When the tension stress p is continuously increased, however, permanent deformations will become apparent in addition to the elastic extensions.

The component of the external work spent in internal friction (molecular rearrangement) will in any case result in a heating effect. It can be proved thermodynamically that the equilibrium between the external and internal forces will be disturbed when the work done in friction—i.e., heating—predominates over the work done in deformation—i.e., cooling. This critical point in the tension test is therefore fixed by the observation that:

$$\Delta T/\Delta z > 0, \text{ and } \Delta T/\Delta p > 0$$

Starting from this point, the test rod will, with increasing force, continue to impart heat to its surroundings. If it be permitted to neglect, in the case of a rod of sufficient length, the influence of the parts where the rod is gripped, the heat which leaves the body in the unit of time, t, expressed by $-\Delta Q/\Delta t$, is nothing but the radiation ϕ of the rod. According to the law of Stefan-Boltzmann-Planck, the radiation $\Phi = a\,(T^4 - T_0^4)$ is a universal function of the absolute temperature T of the radiating surface and of the temperature of the surrounding T_0.

We have further to bear in mind that the specific heat c of the specimen will essentially influence the temperature changes as well as the elongation curve. According to the generalization of Dulong and Petit, the product atomic weight M by specific heat c, has a constant value for all metals, in thermal terms $cM = 6.38 = \text{constant}$. It appears probable hence, that there is a thermodynamic equation of state connecting the strengths of all metals with their molecular structures and their thermal properties, and further that this general equation must be of a comparatively simple form.

When we measure the temperature of a test rod while the test is proceeding, the critical stress, p^δ, will be recognized by the reversal in the temperature records.

The temperature determination with the aid of thermo-couples has proved both simple and reliable. Mr. Rasch has used thermo-couples of silver-constan-

tan, copper-constantan, iron-constantan, consisting of wires, about 1 metre in length and 0.5 millimetre in diameter, soldered with a soft solder or with silver. It is not necessary to connect the soldered junction with the rod by means of metallic soldering. It will suffice to press the junction of the wires against the rod with the aid of a rubber strap or by similar means. The cold junctions of the couples, which were clamped to the wires leading over to the galvanometer, were, as a general rule, placed in a common oil tank.

Galvanometers of small period and not of too large a resistance, having a sensitiveness of 1.10^{-8} amp, will suffice as temperature indicators. A small Edelmann chord galvanometer has proved well suited for the study of rapid deformations. For practical purposes it may be more convenient to make the observations with the aid of a mirror galvanometer, throwing its spot of light on a scale. It is important to guard the test rod and the junctions against draughts during the experiment. The commencement of the test should be delayed until the galvanometer has come to rest.

A special thermo-pile has been provided for practical work. It consists of an ebonite box which is clamped with its front to the surface of the rod. This front is formed by a plate of soft rubber, fitted with a longitudinal slit in the center. Within this slit the nine thermo-junctions are so arranged in series that they do not come in contact with the surface of the rod; otherwise the soldered junctions would be short-circuited by the rod. The cold junctions are connected with the binding screws at the back of the box to which the galvanometer leads are joined.

In a test of a brass rod in an annealed condition, Mr. Rasch states that the stress recorder on the Pohlmeyer machine did not give any indication of stretching. The galvanometer curve, however, marked the yield point as sharply defined. Other tests of this rod gave galvanometer curves which mark in the same way, by well-defined inflections, the yield points, which had been raised by the previous loads. In cast iron the reversal occurred only at the moment of fracture.

The thermo-electric method, Mr. Rasch states, has proved efficient in determining the stress distribution and the position of the layer of neutral stress in bending tests of girders; in this test the thermo-junctions were placed at different levels in the cross-section of the girder. The fibers stretched under load are recognized by a fall in temperature, the compressed fibers by a rise in temperature; the stress-strain distribution and the position of the layer of neutral stress are thus indicated. Mr. Rasch states that in experiments with girders provided with broad flanges and small spans the layer of neutral stress is displaced toward the tension sire (up to $e = \frac{1}{4} h$), to a really extraordinary degree.

THE ELEMENTS OF ASSEMBLING OPERATIONS.

A BRIEF SUMMARY OF THE ELEMENTS DIRECTLY AFFECTING THE COST OF ASSEMBLING.

Alfred Spangenberg—Machinery.

A SURVEY of the literature of production engineering will reveal the fact that a disproportionate amount of attention is given to the problems of machine work in comparison with that devoted to the no less important problems of assembling. Yet the determination of proper methods and processes of assembling is peculiarly difficult, since the elements of human judgment and skill enter so largely into the work. It is a much more difficult matter than the analysis and planning of efficient methods of machine work. Some conception of the problems involved in the elaboration of economical, standardized methods in assembling may be gained from the following brief review of an interesting discussion of the elements of assembling operations, contrib-

uted by Alfred Spangenberg to the September number of *Machinery*.

The three factors leading to economical assembling are accurate drawings, accurate machine work, and the use of jigs and gauges. Much has been written on methods of dimensioning drawings and the use of limits as tending to accurate and at the same time cheap production, but the system of giving all unimportant dimensions in inches and common fractions thereof, and expressing precise dimensions in thousandths of an inch with the permissible limit of variation, is worthy of much wider application than is now made of it. Coupled with a thorough system of inspection, it will ensure that the parts function properly when assembled and will prevent the selection of uneconomical methods of machining.

Accurate machine work can be secured only by a thorough system of inspection in the machine departments. Inspection of the finished product alone is not sufficient. Unless the broader system is adopted, great wastes of time are always possible, in fitting poorly machined parts in the assembling department, but especially in waiting for the replacement of spoiled parts in which the error had not been discovered until the parts were delivered as ready for use. The great value of jigs and fixtures, and their bearing on the cost of assembling are to well recognized to require comment.

A careful analysis of the assembly drawings should be made in order thoroughly to understand the purpose of every part of a machine. Once the purpose of the part is clearly recognized, the operations necessary to produce it most economically can be planned. Attention can very profitably be given to the question of rigidity in fits, which can rarely be left to the judgment of the workman. The determination of proper fits and adjustments in assembling work requires experience of a peculiar kind which the ordinary workman does not possess. It may be laid down as a general rule that sliding or revolving machine elements that do not affect the accuracy of the machine's product should be fitted perfectly free, so that there will be no indication of the parts working stiff.

The next step in the study of the drawings will be the planning of systematic methods of assembling to secure rapid and cheap work; all the parts must be assembled in their proper relations to each other and in perfect alignment within the required limits. In general the process that will secure the desired result most directly should be chosen. An intelligent choice involves a thorough knowledge of modern methods, the facilities available in the plant, the works organization, and special tools and appliances.

Once the choice is made, "the drawings must always be followed. No deviations should be permitted. If any mistake is discovered or change found necessary in the interests of economical assembling, then these corrections should be approved by responsible parties and made on the drawings. The importance of this is at once apparent. Standardization without observing this rule is impossible, and neglect of it will result in lax, inaccurate, and totally misleading methods of production. Again, in case of repairs, the new parts can be finished to the drawings with the assurance that they will fit properly. The drawings should always indicate the methods of oiling a mechanism, as this matter if left to the judgment of the assembler, may result in an inefficient system of lubrication."

Errors found to exist as a result of mistake in patterns or in casting should be taken care of at once. When the errors affect clearances, their correction will prevent unnecessary "carving" by chipping or machining. In some cases it is unreasonable to expect entirely to avoid "carving"; such cases should be anticipated before any assembling operations are commenced, and the proper clearance made, to prevent the necessity of taking the machine apart. Study can profitably be given to the problem of substituting machine processes for operations usually performed by hand. It is usually impossible entirely to do away with such hand processes as chipping,

filing, and scraping, but in many instances they can be avoided if proper attention is given to the matter.

Standardization is one of the secrets of economical assembling. Interchangeable manufacturing is really economical manufacturing, yet in many instances its fullest possibilities are not realized. Such practices as leaving stock for adjustment on the hubs of bevel gears, planing taper packings to fit slides that are not planed to gauge, and adjusting parts to fit others that are not standard must be eliminated if economical results are to be expected. By the use of simple forms of gauges, work of this character can be machined standard and made practically interchangeable at a fraction of the cost in assembling. Standard length gauges are no less indispensable in interchangeable work than diameter gauges; in fact, errors in measurement of length are far more likely to occur and cause trouble in assembling than errors in diameter.

The duplication of parts in quantities is another step in economical manufacturing. It may not be advisable to stock complete machines, but in nearly every instance the standard parts can be assembled in lots and kept in stock ready to be placed on the bed of the machine when ordered. Production in quantities means a large reduction in initial cost, and the stocking of parts results in quicker deliveries.

Although the methods and processes of assembling will vary widely with the character of the work and the design of the machine, it is possible to lay down a few fundamental principles which can safely be followed and which are adaptable to many different conditions. As has already been indicated, the design and construction of a machine are intimately correlated. The designer should continually be impressed with the importance of bringing out the best possibilities of manufacture, both as to ease and cheapness of assembling as well as machining. It is important in designing to consider provision for construction on the unit system, in which various parts of the completed machine can be assembled independently and simultaneously. When the design is such that the parts are more or less interdependent, it is usually possible to classify the various members into groups so that the unit system of assembling can be followed to a certain extent. This is especially true of interchangeable manufacturing when the necessity of adjustment is eliminated.

In assembling work it is highly advisable to provide for the same rigid subdivision of labor that exists in the modern machine department. The operations involved in assembling the units should be separated from the erecting process on the beds. "In general, the sequence of operations is somewhat as follows: work coming into the assembling department from the various sources should have all the machining operations completed, the only exceptions being in cases where it is absolutely necessary to leave stock for adjustment, and where, owing to the fact that some parts are interdependent, it is not possible to carry on all the operations of machining at one time. The preliminary assembling operations of such parts as are interdependent consist of the chipping, scraping and aligning operations. Should chipping be necessary on parts that require scraping, then the chipping must be performed first in order to avoid having to take the work apart and to prevent the possibility of springing the pieces. Next in order are the scraping operations on such members as slides, carriages, ways on beds, spindle bearings, etc. This is to facilitate the lining up operations. On small work the use of special surface plates enables the pieces to be scraped and made practically interchangeable without having to try the pieces together, while on large work the element of spring in large surface plates, besides other considerations, precludes their use. The determination of methods for quickly and easily lining up the various brackets, shafts, etc., is a matter that should receive careful thought.

"The operation of assembling the individual units merely involves the chipping of oil grooves, hand reaming, fitting of keys, etc., and combining the

various elements. Whether the units are sent to the storeroom or directly to the erectors, all operations of fitting and adjusting should be completed as far as possible. This will prevent the erectors from losing time by having to run to the vise and bench to fit the parts. All work on the beds and such as cannot be performed when the units are fitted is, of course, done by erectors. This includes the scraping of the larger pieces, the lining up operations, and the final adjustments and testing of the complete machine. The principal point to be observed on erecting work is to plan the methods of combining and adjusting the various units on the bed of the machine so as to avoid having to take the work apart, due to neglect of some vital point."

If assembling is to be done economically, for haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation. A careful consideration of the problems enumerated above and a serious attempt to solve them scientifically will bring surprising results.

FERRO-MANGANESE IN THE BLAST FURNACE.

AN ACCOUNT OF SOME HIGHLY SUCCESSFUL EXPERIMENTS IN A SOUTH RUSSIAN IRONWORKS.

O. Höhl—Stahl und Eisen.

IN an article in *Stahl und Eisen* for July 21, O. Höhl communicates some results of experiments made by Josef Jakobi at Olchowaja, South Russia, on the production of ferro-manganese in the blast furnace. This is a branch of iron-works practice of which the literature is exceedingly scant; in addition to the interest which attaches to the record of remarkably successful results, the infrequency of such detailed communications as Herr Höhl's lends a special interest to his report of the Olchowaja experiments.

Two ores were available for the experiments, of the following compositions:

	I. Per cent.	II. Per cent.
Manganese	51.60	53.50
Iron	1.45	0.90
Phosphorus	0.173	0.25
Silica	7.80	6.20
Alumina	1.12	2.80
Lime	1.80	0.15
Magnesia	2.18	1.80
Baryta	2.20	2.60

The ores were washed almost entirely free of dust, in order to prevent loss of manganese in the form of loose dust. Being rich in manganese and low in silica, they were of first-class quality for the purpose, although the percentage of phosphorus was rather high. The maximum phosphorus content of the ferro-manganese had to be kept down to 0.40 per cent, so that only a small amount of ore No. II could be used.

The desired percentage of manganese in the product was set at not less than 77 per cent. It was calculated that 70 per cent of the manganese in the charge would be recovered, and that the coke consumption would be 2.5 tons per ton of ferro-manganese. The manganese content of the charge was fixed at 83 per cent; the charge itself was made up as follows:—ore No. I, 12,960 pounds; ore No. II, 3,240 pounds; hematite, 360 pounds; limestone, 5,400 pounds; and coke, 18,000 pounds. Of the manganese, 70 per cent was to go into the product, and 10 per cent into the slag; 20 per cent was allowed for loss in dust and by volatilization. The desired proportion of iron in the ferro-manganese was set at about 10.5 per cent; 10 per cent was allowed for loss of iron in slag and dust. With reference to the other elements, silicon, phosphorus and carbon, the charge was calculated so that the final product should contain: manganese, 83 per cent; iron, 10.5 per cent; silicon, 1.0 per cent; phosphorus, 0.4 per cent; and carbon, 5.5 per cent. The yield expected from the charge was 7,200 pounds of ferro-manganese, and 7,600 pounds of

slag (about 106 per cent of the yield of alloy), of the following composition: silica, 26.8 per cent; ferrous oxide, 1.4 per cent; manganese oxide, 14.3 per cent; alumina, 9.0 per cent; lime, 36.7 per cent; magnesia, 5.7 per cent; and calcium sulphide, 12.6 per cent.

The runs were made in an old furnace with four 6-inch tuyeres. The blast was heated in four Cowper stoves to a uniform temperature of 950 degrees C. Previous to making the runs for ferro-manganese, the furnace was used for several days to smelt hematite and to produce 20 per cent spiegeleisen. Thirty-six hours after charging, an alloy with 77.8 per cent manganese was obtained. When the manganese had reached 81 per cent, the intermediate iron, containing on an average 58.7 per cent manganese, was remelted with the charge. The manganese content of the final product varied between 78 and 83 per cent.

When uniform working had been reached, the blast pressure was raised to 16 inches gauge. In order to keep down the temperature of the furnace gases, the ore and coke were moistened and the upper part of the furnace was constantly sprayed with water. These precautions, combined with the rapid descent of the charge under high blast pressure, resulted in a reduction of the temperature of the gases to below 200 degrees C. The usual ignition of the gases in the production of ferro-manganese in the blast furnace was entirely prevented.

Over the whole working period of nine days, the manganese content of the slag varied between 2.41 and 10.87 per cent, corresponding to 3.1 and 14 per cent of manganous oxide. An average sample of the slag made over the whole period had the following composition:

	Per cent.
Silica	30.32
Alumina	10.88
Lime	41.34
Magnesia	2.96
Ferrous oxide	1.41
Manganous oxide	8.52
Phosphorus pentoxide	0.01
Calcium sulphide	3.94
Baryta	0.48

The loss of manganese in the slag was about 6 per cent less than had been anticipated. The total amount of alloy produced during the nine days was 904 tons. The composition averaged:

	Per cent.
Manganese	80.20
Silicon	1.16
Phosphorus	0.38
Carbon	6.46
Iron (by difference)	11.80

The total coke consumption was, roughly, 1,965 tons, or less than 2.25 tons per ton of alloy.

A manganese balance shows that 76.9 per cent of the manganese charged was recovered, and 23.1 per cent lost. The proportion of total manganese passing into the slag was 6.7 per cent. The remaining 16.4 per cent was lost in the dust and by volatilization.

A SPEED-REDUCTION GEAR FOR MARINE TURBINES.

A DESCRIPTION OF THE MELVILLE-MACALPINE-WESTINGHOUSE SOLUTION OF THE SPEED PROBLEM IN MARINE-TURBINE PRACTICE.

Engineering.

THE possibility of solving the speed problem of the marine steam turbine by the interpolation between turbine and propeller shaft of a spur-wheel reduction gear has never ceased to hold an attraction for numerous inventors, but it is many years since this straightforward solution of the problem has been generally, though regretfully, dismissed as impracticable. The announcement is now made, however, that a double-helical spur gear devised by Rear-Admiral George W. Melville and John H. Macalpine, who have patented certain novel features on which they rely for success, has been constructed for Mr. George Westinghouse and is about to be put to a practical test. The gear is intended to transmit 6,000 horse power at 1,500 revolutions of the pinion per minute, the reduction ratio being about 5 to 1. A full technical descrip-

tion and an exposition of the claims of the inventors appeared in *Engineering* for September 17; from this article the information here presented has been obtained.

"The pinions have 35 teeth each and the spur wheels 176, a hunting cog being introduced to equalise wear. The pitch is 1¼ inches, and the pitch helices are at an angle of 30 degrees with the axis of the shaft. One wheel and pinion have, of course, right-handed helices, and the other pair left-handed, so as to eliminate end thrust. The diameter of the pitch circle of the large wheels is about 70 inches, and of the pinions 14 inches. The gear boxes have been designed after a long and comprehensive study of the circumstances which tend to interfere with the proper working of very broad teeth. A small pitch was deemed essential if a reasonable absence of noise was to be secured, and this necessarily meant broad teeth, in view of the fact that 6,000 horse power was to be transmitted with a pitch-line speed of very nearly 100 feet per second, and with a limiting pressure of 453 pounds per lineal inch on the teeth.

"In order to ensure the proper working of such broad teeth, Messrs. Melville and Macalpine have adopted the plan of mounting the pinion shaft in a device which they have dubbed a 'floating frame', the object of which is to cause the alignment and position of this shaft to be controlled wholly by the interaction of the teeth in contact, and not by the greater or lesser skill of the workman in laying out and fitting the bearings, which, moreover, even if exactly right to start with, could not be depended on to maintain permanently their alignment. The 'floating frame' is a heavy steel casting flexibly mounted in the gear box, and supporting in rigid bearings the pinion shaft, but in such a way as to allow of this shaft having a slight longitudinal freedom, so that it can slide axially to and fro within the frame."

Flexible I-beams support the floating frame from the bed plate. The pinion is supported in three bearings; the large gear, being much stiffer, requires only two. The floating frame is made very deep vertically, so as to be exceedingly stiff to withstand deflection by the nearly vertical forces at the bearings. It is also amply stiffened in the horizontal plane to obviate deflection from the weaker horizontal forces. The pinion shaft is driven by a flexible shaft which passes completely through it to the end distant from the coupling to the turbine shaft, where it is keyed and bolted. The axes of the gear and pinion are horizontal and parallel to one another when everything is in correct adjustment. But the I-beams are virtually a hinge, and if the large gear were not in place, or the coupling not connected, the axis of the floating frame and pinion could easily be deflected in a vertical plane through a small angle by a slight flexure of the webs. The coupling is so designed as to transmit no longitudinal forces. The pinion, therefore, has perfect freedom of longitudinal movement in its bearings. The shaft driving the pinion shaft is so flexible that it imposes practically no constraint on the pinion and floating frame such as would prevent slight angular yield of the floating frame supports. Both to its longitudinal position in the floating frame and in the angular position of its axis, the pinion is solely under the control of the forces transmitted by the teeth of the large gear.

"This, it is contended, practically assures a good distribution of pressure under all conditions of load. For, by sufficient running of the gear, it may readily be assured for one particular load; and if the pinion and the floating frame are made sufficiently stiff, this condition will not be seriously changed by increase or decrease of load. The strength of both pinion and floating frame are far in excess of that requisite to sustain the maximum forces to which they will be subject, and their dimensions were made such as to give ample rigidity. For instance, under full load the flexure of the cast-steel floating frame in the vertical plane is so slight that the end bearings will be lowered relatively to the centre by not more than one two-thousandth of an inch. . . . . .

"Given that the axes of the gears are

parallel to start with, the action of the teeth will, it is claimed, force the axis of the pinion into exact alignment with that of the large gear, provided that in the flexure of the I-beams supporting the floating frame the pinion shaft tilts in a vertical plane parallel to that containing the axis of the large gear. If there were no floating frame, and all bearings of the pinion and gear were cast in one bed plate, the longitudinal dimensions remaining unchanged, an error of alignment of the axes in the vertical plane not exceeding one one-thousandth of an inch in the length over the bearings would entirely upset the uniform distribution of the pressure along the faces of the teeth. Hence, with the most careful work, the above assumption may not be fulfilled with sufficient accuracy Even if they were exactly fulfilled when the gear was first completed, inequality of the side wear of the bearings might cause the axes to stand at a sensible angle to one another in the horizontal plane."

Provision is made for measuring such errors of alignment by vertical and horizontal gauges placed so that the errors can be readily measured when the gear is running. When an error of alignment exists, with the involute teeth here used, it can be shown that, if the teeth were perfectly rigid, there would be point contacts at certain points, and that at others the teeth would actually stand open a small amount, called by Messrs. Melville and Macalpine the "opening of contact." "If in changing from perfect alignment the pinion turned about either a vertical or a horizontal transverse axis, it may readily be shown that the opening of contact would be a considerable fraction of the sum of the errors shown by the end gauges. On the other hand, the inventors state that the action of the floating frame in combination with involute teeth is such as to constrain the pinion to turn about an axis parallel to what is known as the line of action of the teeth—in the present case, an axis inclined 14 degrees 30 minutes to the vertical—and this is precisely the movement which reduces the opening of contact to a minimum. . . . . .

"The only condition which could cause serious disturbance of the tooth pressures is an excessive heating of the pinion above the temperature of the gear. But the design provides for a copious application of lubricating and cooling oil, especially to the pinion, which has most tendency to heat. The cover, also, is so arranged as to draw in air at the ends by the fan action of the gears. Besides, water can be circulated between the pinion and the flexible shaft. But it is not anticipated that the heat to be removed will be so great as has been provided for. If the coefficient of friction at the tooth contacts is 0.1, it can readily be shown that the frictional loss at the teeth will be under 1 per cent. So that even if the gear were transmitting 6,000 horse power—the very highest power hoped for—this friction loss would be under 60 horse power. As at least one-half will go to the large gear, where it will readily be dissipated from the large surface, there is left under 30 horse power to remove from the pinion, which, with the various means provided should present no difficulty. If then this control of the heat is assured, there will, it is claimed, be practically perfect tooth contacts; this, with the fine pitch and the spiral gears (avoiding sudden entering or leaving contact of one whole tooth at a time), will, it is asserted, ensure reasonably quiet running of the gears."

From a comparison of the gear under consideration with a right-angled worm gear which is reported to have run successfully at 15,000 feet per minute with a contact pressure of 350 pounds per square inch, the extreme constants chosen by Messrs. Melville and Macalpine seem well within practical limits. Without experiment it is, of course, impossible to predict the limit of safe load, but it is interesting to consider one or two cases. At 1,000 revolutions per minute and 283 pounds per inch of tooth contact, the gear would transmit 2,500 horse power. Applied to the famous ship *Aberdeen*, by the engines of which triple expansion was introduced and which was of about this power, the gear would save in weight of main engines 65

per cent. If this design will transmit 2,500 horse power, it is claimed that similar gears could be applied with great saving of weight and space to all steamships up to 18 knots, which comprise 95 per cent. of all the ships afloat. The gear as at present designed, for 1,500 revolutions and 453 pounds of tooth contact, is expected to transmit 6,000 horse power. If this be realised, the gear would be of the correct power for the *Dreadnought*, and applied to her would save fully 50 per cent. of the weight of her turbines, besides reducing boiler weights. "Increasing, by the law of comparison for similar machines, the dimensions and power of the present design, from 6,000 horse power, a size is obtained suitable for the *Mauretania* with three large screws of the same total power as the present four-screw ship. Here again the weight of the turbines would, it is claimed, be halved, as also the engine-room length. The boilers also, as in the *Dreadnought*, would, it is considered, be materially reduced."

THE PROSPECTS OF THE TEHUANTEPEC RAILWAY.

AN ESTIMATE OF THE EFFECTS OF OPENING THE PANAMA CANAL ON THE TRAFFIC OF THE TEHUANTEPEC ROUTE.

The Engineer.

AT the time when the reconstructed Tehuantepec Railway was opened, a little less than three years ago, Mr. Gilbert C. Terry, in an article contributed to this Magazine, expressed a very optimistic opinion of its economic possibilities. From a review running through three recent numbers of *The Engineer*, it is apparent that his prediction of successful competition with the Panama Railway and of a large measure of commercial success was amply justified. In the last article of *The Engineer's* series, attention is turned to the larger problem, the possibility of a redistribution of traffic following the opening of the Panama Canal. In general, the conclusion reached is that the Tehuantepec Railway, one of the best constructed lines in the world, capable of sustaining all the traffic which can be obtained for it, with its terminal harbors, Puerto Mexico on the Atlantic and Salina Cruz on the Pacific, arranged and equipped after the best practice of Europe and America, will have little to fear from the opening of the water route across the Isthmus; on the contrary, the Mexican railway is likely to prove a serious competitor of the Canal.

It has been stated frequently that in building the Panama Canal, the United States has been actuated by strategic and commercial rather than by financial considerations, and that the Government is quite prepared to operate the Canal for some years at a heavy loss. While the Tehuantepec Railway has abundant working capital, it is in no such strong financial position as the United States Government, and it is doubtful that it could withstand for any length of time a rate war such as is threatened. It must be remembered, however, that the rates through all canals are on gross tonnage, and that in order to save canal tolls a large part of the tonnage crossing the Isthmus will go by rail or will be taken through the Canal on lighters. "This consideration and many others will bear upon the railway rate question; and by the results will the prospects and the future of the Tehuantepec route be controlled.

"Even, however, when the Panama Canal is open there must still remain a heavy traffic for the Tehuantepec Railway, which will secure a large proportion of freight for the west coasts of Mexico and South and Central America, unless, indeed, the Panama rates should be reduced below a profit-earning point, and equally desirable facilities for handling the traffic, or the privilege of breaking bulk and distributing from terminals at both termini, should not be assured. In any case, the vessels for the Orient and Australia would pass through the Pan-

ama Canal. It will take years, moreover, to develop practical methods of handling the Panama Canal business. A large number of smaller ships will have to distribute the cargoes of the large ships; the railway will handle very likely one-half of the freight that will cross the Isthmus, if that route is to compete with the Tehuantepec and the Suez Canal; and the rates will necessarily have to be very low if greatly to affect transcontinental rates in Mexico. If these rates are not made low enough to reduce greatly such transcontinental charges, then the Tehuantepec Railroad and the Suez Canal will continue to enjoy the greater part of the traffic. . . . . .

"There can be no question that the Tehuantepec route has been well organised, the facilities afforded to both steamship and railway companies having met with the emphatic approval of shippers. Cargoes are accepted at through rates and on through bills of lading between many Mediterranean ports, such as Trieste, Fiume, Patras, Palermo, Naples, etc., for all ports on the Pacific between British Columbia and Valparaiso; while the same facilities are in force for the ports of Antwerp, Hamburg, Havre, Barcelona, Bordeaux, Lisbon, London, Marseilles, Stockholm, Southampton, Manchester, Liverpool, and Rotterdam. . . . . .

"It is true that the character of the traffic of the Tehuantepec Railroad will probably change on the opening of the Canal. It is certain, by that date, owing to the rapid extension of railroad development from the Isthmus of Tehuantepec through Guatemala and even Salvador, linking up Puerto Mexico with an important territory in Central America, that considerable tonnage from this district will always be assured to the Tehuantepec Railroad, as such tonnage must naturally find its way to the splendid terminals of the Tehuantepec Railroad, both on the Atlantic and the Pacific, and to the steamship connections from such ports to all parts.

"Then, again, the mineral resources of the State of Oaxaca, in Mexico, have not yet been tapped, and from the information now to hand it would appear that some few years hence the Tehuantepec Railroad will be called upon to handle an enormous mineral traffic—principally iron ore—a traffic which is not so attractive to the Tehuantepec Railroad to-day.

"One of the earliest, as well as one of the most important, contracts made by the Tehuantepec Railroad was with the American-Hawaiian Steamship Company, which called for a minimum of 250,000 tons of Hawaiian sugar annually—a figure which has already been considerably increased in the short time that the route has been open. European traffic commenced about October, 1908, and since that date the railroad has successfully handled nearly 25,000 tons of coffee, as well as carrying a large volume of dried fruit from the Pacific coast to both New York and Europe; while the total traffic handled by the railroad last year amounted to the considerable figure of 650,000 tons—a result, however, which will be exceeded this year. . . . . .

"No fewer than thirteen steamers a month now leave Europe for Puerto Mexico, and with the exception of the fortnightly passenger steamers of the Hamburg-Amerika Line, all these steamers make Puerto Mexico their first Mexican port of call, whereas formerly they all proceeded first to Vera Cruz, then to Tampico, and lastly to Puerto Mexico. Eight steamship lines in all are giving services from Europe to Puerto Mexico, and of these, four lines are British—viz., the Harrison Line, the Leyland Line, the Royal Mail Steam Packet Company, and the Cuban Line. The remaining four lines are:—The Hamburg-Amerika, of Hamburg; the Cie. Générale Transatlantique, of Paris; the Cia. Trasatlantica, of Barcelona; and the Norway-Mexico Gulf Line, of Christiania. In addition to these, the American-Hawaiian Line maintains a weekly service of freight steamers of 8,500 tons between New York and Puerto Mexico; there is a fortnightly service by the Wolvin Line between Texas City and Puerto Mexico, and three or four steamers a month of the Mexican Navigation Company, giving regular connections with all Mexican ports on the Gulf.

"On the Pacific, the Tehuantepec Railroad's terminal port of Salina Cruz is served by seven lines—namely, the American-Hawaiian, giving three sailings a month to San Francisco, Puget Sound, Portland, and the Hawaiian Islands; the Kosmos Line, two sailings a month to all ports as far south as Valparaiso, and as far north as Puget Sound; the Compañia Naviera del Pacifico, with sailings every ten days to all Mexican ports; the Jebsen Line, with monthly sailings to all ports between Corinto, in Central America, and British Columbia; the Canadian-Mexican Pacific Line, with monthly sailings to Victoria and Vancouver; the Pacific Mail, monthly passenger service to all Central American and Mexican ports and San Francisco. In addition, there is a service to Hong Kong and the Orient by the Mexican Oriental Steamship Line, and by the Tokyo Kisen Kaisha.

"Another more or less important factor in the development of the Tehuantepec Railroad is that the Salvador Railway Company has made arrangements to establish a weekly steamship service of its own between Acajutla, the terminal of the Salvador Railway, and Salina Cruz. As Acajutla is only thirty-six hours' steam from Salina Cruz, the weekly service of steamers, proceeding direct from Acajutla to Salina Cruz without any intermediate calls, must result in giving Salvadoreans such a service as they have never had in the past. It will enable them to reach Mexico City, the Mecca of all Central Americans, in less than four days.

"If the steamship arrangements entered into by the Tehuantepec route are encouraging, others which may be entered into in some of the great United States railway lines are hardly less so. Among these may be mentioned as probable the Vanderbilt System, which includes the New York Central and Hudson River Railroad, the West Shore, the Boston and Albany, the Rutland, the Michigan-Central, the Lake Shore and Michigan-Southern, the Chicago-Cleveland, the Cincinnati and St. Louis, the Lake Erie and Western, the Chicago-Indianapolis, and the Southern, with their numerous connections and spurs. The various railroads comprised in this group take an enormous tonnage from the commercial centres of the United States, such as New England, New York, Pennsylvania, Ohio, Indiana, Illinois, and Michigan; and it would probably be no exaggeration to say that, from first to last, these lines handle 75 per cent. of the manufactured products of the United States. From this section of the North American Republic is shipped an immense tonnage across the continent for consumption in the Western and Pacific Coast States, as well as in the Prairie and Cereal States of the Northwest and Middle West. Of this 75 per cent., one-third, at least, might at no very distant date easily pass over the Tehuantepec route, more especially when it is considered that, while it takes from three weeks to five months for freight to go from New York to San Francisco by rail, shipments are being regularly made by way of the Isthmus of Tehuantepec in less than thirty days. It would appear that if the New York Central System adopt the Tehuantepec route it may well lead to a complete transformation in transcontinental traffic, and would confer upon the Tehuantepec Railway an enviable distinction by making it the greatest highway of transportation that the world has ever seen. That the pioneers of the undertaking are not blind to its great future is clear from the fact that they have considered the advisability of not only doubling but of quadrupling the lines across the Isthmus, and this in full consideration of what the Panama Canal may mean for them when it is once open. Even should the Canal prove as successful as its most ardent advocates profess to believe, however, the Tehuantepec Railroad will, as we have pointed out, still secure as much traffic as it can conveniently handle. By the time that the Canal is completed, freight business will have increased so enormously and contracts will have been made so far ahead, that the route first to be opened will have little to fear."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING..... 283
ELECTRICAL ENGINEERING..... 291
INDUSTRIAL ECONOMY..... 296
MARINE AND NAVAL ENGINEERING..... 298
MECHANICAL ENGINEERING..... 301
MINING AND METALLURGY..... 311
RAILWAY ENGINEERING..... 318
STREET AND ELECTRIC RAILWAYS..... 322

CIVIL ENGINEERING.

BRIDGES.

Bascule.

Scherzer Rolling Lift Bridge Across Ngawun River, Burma. Illustrated description of a rolling-lift railway bridge. 800 w. Engr, Lond—Sept. 17, 1909. No. 8134 A.

Blackwell's Island.

The Blackwell's Island Bridge. Editorial on a pamphlet issued by the Penn. Steel Co. giving expert testimony in regard to its strength. 1800 w. R R Age Gaz—Sept. 10, 1909. No. 7694.

Blackwell's Island Bridge, New York. Frank W. Skinner. Illustrated detailed description of this bridge and the methods of construction. 3500 w. Engng—Aug. 20, 1909. Serial, 1st part. No. 7440 A.

Concrete.

The Monroe St. Bridge, Spokane, Washington; A Concrete Bridge Containing a 281-ft. Arch. Illustrated detailed description of a bridge soon to be constructed which will contain the longest concrete arch yet attempted. 1500 w. Eng News—Sept. 2, 1909. No. 7534.

We supply copies of these articles. See page 323.

Some Concrete Culverts and Small Bridges on the Slateford-Hopatcong Cut-Off of the Delaware, Lackawanna & Western R. R. Illustrated descriptions. 1200 w. Eng News—Sept. 30, 1909. No. 8206.

Design.

Live-Loads and the Life of Railway Bridges. For What Loading Should Railway Bridges Be Designed? Editorial discussion. 1200 w. Eng News—Sept. 16, 1909. No. 7899.

Foundations.

Foundation Work for C. and N. W. Railroad Bridge Across the Mississippi River at Clinton, Iowa. M. Deutsch. Illustrated description of the construction of foundations for one of the longest continuous truss-span bridges in the world. Ills. 3500 w. Sch of Mines Qr—July, 1909. No. 7891 D.

Masonry.

The 180-Ft. Stone Arch Bridge at Wiesen, Switzerland. Illustrations and information of an arch of unusual proportions built on a meter-gage branch railway in Switzerland. 2000 w. Eng News—Sept. 16, 1909. No. 7895.

New York City.

The Bridges of New York City. T. Kennard Thomson. In this second article the East River bridges and the smaller structures of Brooklyn, Queens, and Richmond are considered. Ills. 3000 w. Engineering Magazine—Oct., 1909. No. 8174 B.

Piers.

The Reconstruction of a Pier of the Poughkeepsie Bridge. Illustrates and describes details of new columns, girders, and bracing. 1500 w. Eng Rec—Sept. 25, 1909. No. 8066.

Construction of the Beaver Bridge Piers. Detailed description of the methods used in constructing this bridge across the Ohio River. 2000 w. Eng Rec—Sept. 11, 1909. No. 7671.

Pontoons.

Design of an Iron Pontoon Foot-Bridge (Construction und Berechnung einer eisernen Schiffslandebrücke für Fussgänger). W. Schulz. Mathematical. Ills. 1500 w. Elektrotech Rund—Aug. 28, 1909. No. 7989 D.

Reconstruction.

Replacing Short Span Railroad Bridges Under Traffic. Illustrated description of methods used on the Auburn Div. of the Lehigh Valley R. R. 1000 w. Eng Rec—Sept. 11, 1909. No. 7669.

The Widening of Blackfriars Bridge. Illustrated detailed description of the engineering features of the work, and other information. Plates. 5000 w. Engng—Sept. 10, 1909. No. 7864 A.

Steel.

New Bridge of the Kanawha & Michigan Ry. Over the Ohio River at Pt. Pleasant, W. Va. J. A. Stocker. Illustrated description of rebuilt bridge and approaches, describing methods of erection. 3500 w. Eng News—Sept. 9, 1909. No. 7623.

See also Pontoons, under BRIDGES.

Viaducts.

Great Engineering Works on the Canadian Pacific Railway. J. E. Schwitzer. Read before the British Assn. at Winnipeg. Describes the huge Lethbridge viaduct in Alberta, and the grade reduction in the Canadian Rockies. Ills. 7000 w. Can Engr—Sept. 17, 1909. No. 7834.

The Makatote Viaduct. Illustrated description of this steel viaduct on the North Island Main Trunk Ry. of New Zealand. Plate. 1800 w. Engng—Sept. 3, 1909. No. 7747 A.

The Erection of the Fades Viaduct (Construction et Montage du Viaduc des Fades). L. Le Chatelier. Illustrated description of the erection of this long, high, steel structure over the valley of the Sioule. 5300 w. Bul Soc d'Encour—July, 1909. No. 7916 G.

The Assopos Viaduct, Greece (Le Viaduc de l'Assopos, Greece). Georges Bodin. Illustrated description of this steel viaduct 176 metres long with an 80-metre arch span. 4000 w. Génie Civil—Aug. 14, 1909. No. 7935 D.

CONSTRUCTION.

Brick.

The Supervision of Brickwork. Suggestions for inspection, selection of bricks, the mortar, and features of the work. 2500 w. Builder—Aug. 28, 1909. No. 7632 A.

See also Sewers, under MUNICIPAL.

Coal Pockets.

A Large Steel Coal Storage Building. Illustration and brief description of storage shed and conveyor at Wende, N. Y. 1000 w. Eng Rec—Sept. 4, 1909. No 7556.

Columns.

See Concrete, and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Concrete.

A Concrete Industrial Village. Frederic F. Lincoln. Illustrates and describes buildings at Mineville, N. Y. 1500 w. Cement Age—Sept., 1909. No. 7809.

The Design and Construction of Forms for Concrete Work. A series of articles presenting approved methods and criticizing bad examples. Ills. 1800 w. Engng-Con—Sept. 22, 1909. Serial. 1st part. No. 8008.

The Wet and Dry Mixtures of Concrete. M. H. Landis. Things to be considered in the manufacture of concrete building blocks, and other concrete construction. 1200 w. Cement—Aug., 1909. No. 7570 C.

See also Fence Posts, under CONSTRUCTION.

We supply copies of these articles. See page 323.

Contractors' Plants.

Construction Plants for the Pacific Locks of the Panama Canal. Illustrated description of the material handling plant at the Miraflores locks and the Pedro Miguel lock. 3000 w. Eng Rec—Sept. 25, 1909. No. 8063.

Cost Keeping.

Accounting and Cost Methods for Contractors. Considers methods used by the writer, giving forms, and information. 2500 w. Engng-Con—Sept. 1, 1909. Serial. 1st part. No. 7519.

Earth Filling.

Density and Draining Capacity of Artificial and Natural Mixtures of Sand and Gravel. E. C. Murphy. Presents certain principles determined in investigations made in the U. S. Geol. Surv. laboratory. 1000 w. Eng News—Sept. 23, 1909. No. 8020.

Earthquake.

Construction Against Earthquakes (Le Costruzioni antisismiche). A. Danusso. First prize paper presented in a recent competition in Italy. Ills. 8000 w. Il Cemento—Aug. 30, 1909. No. 7943 D.

For Calabria and Sicily (Pro Calabria e Sicilia). Vittoria Gianfranceschi and Giulio Revere. Second prize paper in a recent competition on earthquake construction in Italy. Ills. 2500 w. Monit Tech—Aug. 20, 1909. No. 7944 D.

Excavation.

Hammer Drills Applied to Rock Excavation in Sewer Construction at Bloomington, Ind. George L. Thon. An illustrated account of the work. 2200 w. Eng News—Sept. 9, 1909. No. 7625.

Fence Posts.

Cement and Concrete Fence Posts. H. M. Bainer. H. B. Bonebright. Shows how to make the posts, the best forms, mixtures, reinforcements, wire fasteners, cost and general practicability. Ills. 9500 w. Colo Agri Col. Bul. 148—June, 1909. No. 8032 N.

Fireproof.

Fire-Resistant Construction of Buildings. An informal discussion at the annual convention, July 8, 1909. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8188 E.

Grouting.

The Injection of Cement Grout Into Masonry (Note sur les Injections de Coulis de Ciment dans les Maçonneries). M. Luquet. Describes the apparatus used, composition of grout, and cost of injection, in the practice of the Metropolitan of Paris. Ills. 2200 w. Ann d Ponts et Chaussées—1909-IV. No. 7910 E + F.

Piling.

Concrete Piles. Discussion of paper by Howard J. Cole. 5000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8191 E.

Concrete Piles. J. F. Springer. The present article deals with foundation construction upon corrugated and molded piles. Ills. 3500 w. Cassier's Mag—Sept., 1909. Serial. 1st part. No. 7779 B.

Large Concrete Piles. William F. Johnston. Illustrated description of piles built in the ground, used in Europe. 1500 w. Eng Rec—Sept. 25, 1909. No. 8071.

The Wemlinger Steel Sheet Piling. An illustrated article giving information in regard to this piling and its use. 2500 w. Ir Age—Sept. 9, 1909. No. 7607.

Plates.

The Elastic Equilibrium of Thick Circular Plates (Équilibre élastique des Plaques circulaires épaisse). M. Mesnager. Mathematical discussion. 14000 w. Ann d Ponts et Chaussées—1909-IV. No. 7911 E + F.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Reinforced Concrete.

A Large Reinforced-Concrete Dome on a Church in Los Angeles, Cal. Illustrations with brief description. 1000 w. Eng News—Sept. 2, 1909. No. 7532.

The Use of Ferro-Concrete in Monumental Architecture. Translated from a lecture given the Austrian Society of Engineers and Architects by Alexander Edler v. Monteforte. Ills. 2500 w. Archt, Lond—Sept. 17, 1909. Serial. 1st part. No. 8102 A.

Moments in Continuous Reinforced-Concrete Beams Under Uniform Loading. R. E. Spaulding. A mathematical analysis. 1500 w. Eng News—Sept. 30, 1909. No. 8204.

A Graphical Method for Determining the Stresses in, and Fixing the Dimensions of, Reinforced-Concrete Beams (Graphisches Verfahren zur Ermittlung der Spannungen und direkten Dimensionierung von Plattenbalken aus Beton-Eisen). Emil Heidecker. Detailed demonstration. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 14, 1909. No. 7988 D.

See also Wharves, under WATERWAYS AND HARBORS.

Retaining Walls.

The Design of Retaining Walls. Information from the Bul. of Am. Main. of Way Assn. Gives data regarding prevailing practice, with diagrams. 2500 w. Eng Rec—Sept. 11, 1909. No. 7668.

Roofs.

Self-Supporting Curved Iron Roofs. T. McGill. Considers their limitations and details of construction. Ills. 500 w. Mech Wld—Sept. 10, 1909. Serial. 1st part. No. 7854 A.

Steel.

The Metropolitan Life Building, San Francisco. Illustrates and describes de-

tails of a concrete and steel structure of interest. 1000 w. Eng Rec—Sept. 11, 1909. No. 7672.

The Prudential North Building Addition. Illustrated description of a new 12-story extension in Newark, N. J. 1200 w. Eng Rec—Sept. 25, 1909. No. 8064.

The Y. M. C. A. Central Building, Philadelphia. A 6-story steel-frame structure, having interesting features of equipment and arrangement requiring in some cases special treatment of the steel framework. Ills. 2000 w. Eng Rec—Sept. 18, 1909. No. 7818.

The Design of Members Subjected to Combined Stresses. E. L. Hancock. Report of tests of steel under combined stresses, giving results in a form available for use. 1600 w. Eng News—Sept. 2, 1909. No. 7539.

The Transverse Resistance of Rods of Variable Moment of Inertia (Ueber die Knickfestigkeit von Stäben veränderlichen Trägheitsmomentes). Fr. Engesser. Mathematical. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—Aug. 20, 1909. No. 7985 D.

Recent Types of Steel Construction (Neuere Systemformen im Eisenhochbau). Franz Czech. Refers particularly to long-span roof trusses for industrial buildings. Ills. 2200 w. Stahl u Eisen—Aug. 25, 1909. No. 7957 D.

See also Coal Pockets, under CONSTRUCTION.

Tunnels.

The New York Tunnel Extension of the Pennsylvania Railroad. The East River Division. Alfred Noble. An introductory outline of work to be described in detail in later papers. Plans. 4500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8183 E.

The New York Tunnel Extension of the Pennsylvania Railroad. Charles W. Raymond. A brief description of the general plan adopted for conducting traffic into and through New York, considerations involved in designing the work, and the effects expected. Map and plans. 9500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8182 E.

MATERIALS OF CONSTRUCTION.

Brick.

Investigation of Sand-Lime Mixtures (Essais sur le Silico-Calcaire). E. Leduc and Ch. de la Roche. Gives results of elaborate laboratory experiments and a review of the sand-lime brick industry in England, Germany and Holland. Ills. 40000 w. Bul du Lab d'Essais—Nov. 13, 1908. No. 7908 N.

See also same title, under CONSTRUCTION.

Cement.

Cement in Sea-Water. A. Poulsen. Report on the trials in Norway and Sweden commenced in 1896, with results. Ills. 4500 w. Soc Scandinavian Port Cement Mfrs—Sept., 1909. No. 7788 N.

Concrete.

Progress Report of Special Committee on Concrete and Reinforced Concrete. Continued discussion. 8000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8187 E.

The Compressive Resistance of Blocks and Columns of Concrete and Stone. A study of the stresses produced by compression and methods of increasing the resistance. 2500 w. Cement—Aug., 1909. No. 7569 C.

Tests of Plain and Reinforced-Concrete Columns. M. O. Withey. Read before the Am. Soc. for Test. Mat. Reports tests made in the laboratory at the Univ. of Wis. during the past year. 2500 w. Eng News—Sept. 16, 1909. No. 7896.

Impurities in Sand for Concrete. An informal discussion at the annual convention, July 8, 1909. 6000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8189 E.

Structural Materials in Parts of Oregon and Washington. N. H. Darton. Reports results of an investigation intended mainly to ascertain local resources of the gravel, sand, and crushed rock used in concrete. Ills. 11500 w. U S. Geol Surv—Bul. 387. No. 8146 N.

Fireproofing.

Inflammable Substances. William H. Hunt. Discusses inventions for rendering wood and textiles fireproof. 1500 w. Cal Jour of Tech—Sept., 1909. No. 7880.

Reinforced Concrete.

Reinforced Concrete Columns. W. Noble Twelvetrees. The present article discusses Prof. Talbot's tests. 2500 w. Engng—Sept. 10, 1909. Serial. 1st part. No. 7863 A.

Tests on Bond Between Steel and Concrete. H. C. Berry. A report of tests made to determine the change in bond strength as age increased for specimens stored in air and in water, and to compare the bond strength of different forms. 1200 w. Eng Rec—Sept. 4, 1909. No. 7561.

Steel.

Some Experiments on Solid Steel Bars Under Combined Stress. C. Alfred Smith. Compares results of different tests made to determine the cause of elastic failure of ductile materials, attempting to reconsile divergent data. 4000 w. Engng—Aug. 20, 1909. No. 7441 A.

Economic Study of the Use of High-Tension Carbon Steel for Bridges (Etude économique de l'Emploi de l'Acier au Carbon à grande Résistance, pour la Construction des Ponts). J. A. L. Waddell. A reply to criticisms of the author's

paper on "Nickel Steel for Bridges." Ills. 4500 w. Génie Civil—Aug. 7, 1909. No. 7933 D.

Timber Preservation.

Difficulties in the Practical Work of Creosoting Timber. John C. Oakes. Describes the Bethel dead oil of coal tar process, and refers to other processes. 6000 w. Eng News—Sept. 2, 1909. No. 7541.

MEASUREMENT.

Mensuration.

The Computation of Area. Frank J. Gray. Deals with the computation of various forms, such as rectangles, triangles, polygons, etc. 2000 w. Surveyor—Sept. 3, 1909. Serial. 1st part. No. 7737 A.

Surveying.

Phototopography on the Alaskan Boundary Survey. Notes from a paper by P. W. Greene, before the Can. Soc. of Civ. Engrs. describing the methods employed. 3000 w. Eng Rec—Sept. 25, 1909. No. 8068.

MUNICIPAL.

Catch Basins.

Data on Methods and Cost of Cleaning Catch Basins, Obtained from Practice in the Cities of Boston and Worcester, Mass. Abstract of report of Metcalf & Eddy. Describes methods, giving comparative results. 1500 w. Engng-Con—Sept. 15, 1909. No. 7797.

City Improvement.

Preparation of Plans and the Assessment of Betterments in Boston, and the Laws Governing the Same. Frank O. Whitney. Reviews changes since 1891, and discusses the working of the laws relating to the laying out of streets and assessment of betterments. 1500 w. Jour Assn of Engng Socs—Aug., 1909. No. 8062 C.

Drainage.

The Hauff Graphical Method of Designing Drainage Canals (Die graphische Berechnung städt. Kanalnetze nach Ingenieur Hauff). Maximilian Vicari. Demonstration of method of designing storm-water sewers. Ills. 2500 w. Gesundheits-Ing—Aug. 21, 1909. No. 7982 D.

Pavements.

The Detailed Cost of Constructing 19,067 sq. yds. of Belgian Block Pavement at Baltimore, Md. Describes work and gives itemized costs. 2000 w. Engng-Con—Sept. 22, 1909. No. 8009.

Unsatisfactory Experience with Petrolithic Pavements at El Paso, Tex., and Los Angeles, Cal. A letter from J. L. Campbell, and reports from cities named. Ills. 6000 w. Eng News—Sept. 23, 1909. No. 8017.

Refuse Disposal.

City Refuse and Its Disposal. H. deB. Parsons. Lecture at Rensselaer Poly. Inst. Gives a general classification of waste materials discussing their collection, methods of disposal and related subjects. 6000 w. Engng-Con—Sept. 1, 1909. No. 7518.

Roads.

A Third International Road Congress. Report of the conference at Seattle. The present article gives Andrew Rinker's paper on "Creosoted Wood Block Street Paving," and extract from address of A. W. Campbell on "Road Improvement in Ontario, Canada." 6500 w. Surveyor—Sept. 10, 1909. Serial. 1st part. No. 7848 A.

The Road Improvement Bill. Discusses the proposed Board in England, and its powers, giving a synopsis of the bill. 2500 w. Surveyor—Sept. 3, 1909. No. 7739 A.

Road Materials and Some Simple Rules for Testing Them. Austin B. Fletcher. Read at meeting of the First Congress of Road Builders. The discussion is limited to the materials found in Massachusetts. 3500 w. Engng-Con—Sept. 1, 1909. No. 7517.

Earth Roads. Maurice O. Eldridge. From a paper read at the first Am. Cong. Suggestions for the laying out and construction. 2500 w. Can Engr—Sept. 24, 1909. No. 8086.

Concrete Roadways. Ernest M'Cullough. First prize paper. Considers this material from the standpoint of economy, of sanitation, and acceptability, discussing the construction and materials. 5500 w. Engng-Con—Sept. 1, 1909. No. 7516.

Sub-Grade Preparation in Road Construction. James H. MacDonald. Abstract of paper before the first Am. Cong. of Road Bldrs. Directions for a well-built sub-grade. 1800 w. Engng-Con—Sept. 22, 1909. No. 8010.

The Development of Modern Road Surfaces. W. H. Fulweiler. Reviews briefly the ancient roads, and later street improvements, illustrating and describing types of road construction, and discussing the effect of automobiles, dust prevention, etc. Ills. 8000 w. Jour Fr Inst—Sept., 1909. Serial. 1st part. No. 7884 D.

The Problem on Roads. J. R. Findlay. Describes the tarring of roads, and discusses materials for road-making. 2000 w. Surveyor—Sept. 10, 1909. No. 7849 A.

Has Experience Demonstrated that the Oiling of Roads Is the Most Satisfactory or Economical Method of Preventing Dust and Preserving the Road Surface? A discussion at the annual convention, July 8, 1909. 2000 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8190 E.

Tar and Its Uses in Modern Road Construction. E. Parnell Hooley. Read at first Am. Cong. Discusses ordinary country roads. 2200 w. Can Engr—Sept. 24, 1909. No. 8087.

We supply copies of these articles. See page 323.

The Cost of Adapting Macadam Roads to Automobile Traffic. Henry Tipper. Gives some details of costs, which will vary in different places and under different conditions. 1800 w. Munic Engng—Sept., 1909. No. 8052 C.

Sanitation.

Civic Sanitation. Frank K. Chew. A brief account of what is being done by the health department of New York City. Ills. 1200 w. Dom Engng—Sept. 11, 1909. No. 7708.

The Sanitary Significance of Bacteria in the Air of Drains and Sewers. C.-E. A. Winslow. Summary and conclusions of a report made to the Sanitary Committee of the Nat. Assn. of Master Plumbers of the U. S. 3000 w. Eng News—Sept. 2, 1909. No. 7533.

Sewage Disposal.

The Work of the Royal Commission on Sewage Disposal. H. Lemmoin-Cannon. Discusses some points of interest brought out in the latest Blue Book. 4000 w. Builder—Sept. 18, 1909. No. 8104 A.

Sewage Disposal and Treatment by Electricity. Harry E. Mayhew. An account of a sewage purification plant at Santa Monica, Cal. Ills. 1200 w. Dom Engng—Sept. 11, 1909. No. 7707.

The Durham Main Sewerage Works. H. W. Taylor. Reviews the original scheme of sewage disposal, and describes the scheme finally adopted, with information related. Ills. 3000 w. Surveyor—Sept. 3, 1909. No. 7738 A.

Baltimore's Sewage Disposal Plant. Illustrated detailed description of an extensive plant under construction. 2500 w. Mfrs' Rec—Sept. 30, 1909. No. 8169.

The New Sprinkling Filter at Reading. Illustrated description of the addition to the sewage purification plant which has doubled the filtering area. 3500 w. Eng Rec—Sept. 25, 1909. No. 8067.

The Demonstration of the Hampton Doctrine (Ueber die Beweisführung der Hampton doctrine). A. Lübbert. A reply to the criticism of W. O. Travis in the *Surveyor*. Serial. 2 parts. 3000 w. Gesundheits-Ing—Aug. 14 and 21, 1909. No. 7981 each D.

See also Sterilization, under WATER SUPPLY.

Sewers.

Comparative Efficiency and Cost of Brick Masons' Work by Contract and by Day Labor in Sewer Construction. A comparison of work in Boston and vicinity. 1500 w. Engng-Con—Sept. 22, 1909. No. 8011.

See also Excavation, under CONSTRUCTION.

Sidewalks.

Sidewalk and Curb Design and Construction. Selections from a pamphlet of instructions issued by the Board of Public Works of Poughkeepsie. Ills. 2500 w. Munic Engng—Sept., 1909. No. 8054 C.

WATER SUPPLY.

Ashokan.

Progress on the Ashokan Reservoir. Information concerning the construction of this 127,000,000,000 gal. for the additional supply of New York City. 4500 w. Eng Rec—Sept. 4, 1909. No. 7558.

Dams.

The Behavior of Clays in Earth Dams Built by Hydraulic or by Dry Processes. An interesting discussion by James D. Schuyler, and a reply by F. C. Finkle with report of experiments. 2500 w. Eng News—Sept. 23, 1909. No. 8019.

The Principal Stresses and Planes in a Masonry Dam. Frank Harvey Hummel. Gives a determination of the stresses and principal planes in a dam of triangular section, showing in a diagram the variation of the stresses in magnitude and direction. 600 w. Inst of Civ Engrs—No. 3815. No. 8161 N.

Heightening the Assuan Dam Across the Nile. Frederick Hall Fowler. An illustrated account of the new construction. 6000 w. Eng News—Sept. 30, 1909. No. 8203.

The Failure of an Irrigation Dam. Richard R. Lyman. Illustrated account of the failure of a dam in central Utah, caused by the bottom becoming saturated and slipping. 2000 w. Eng Rec—Sept. 18, 1909. No. 7816.

The Failure of Bluewater Dam in New Mexico. George G. Anderson. Brief account of a failure due to floods. 600 w. Eng News—Sept. 30, 1909. No. 8207.

A Reinforced-Concrete Spillway with Concentrated Crest Length. D. W. Murphy. Illustrated description of a spillway recently constructed at Klamath Falls, Ore. 800 w. Eng News—Sept. 9, 1909. No. 7626.

See Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Distillation.

Modern Plants for the Distillation of Water (I moderni Impianti distillatori d'Acqua). Gustavo Pincherle. Describes briefly the plant necessary, modern apparatus, etc. 3000 w. Monit Tech—Aug. 20, 1909. No. 7945 D.

Filtration.

Notes on Certain Points in the Design of Large Filtration Plants. S. Bent Russell. Gives a brief outline of the component parts of a modern plant, with special attention to the washing of the filters, and notes on certain plants. 4500 w. Jour Assn of Engng Socs—June, 1909. No. 7806 C.

We supply copies of these articles. See page 323.

The New Pittsburg Filters. Hartley M. Phelps. Illustrated description of the largest sand filtering plant in the United States. 3000 w. Munic Engng—Sept., 1909. No. 8053 C.

The Construction of Ten Additional Sand Filters at Pittsburg. Illustrated description of the new covered beds for slow-sand filtration, completing the largest plant in the United States. 4800 w. Eng Rec—Sept. 18, 1909. No. 7813.

Development of Devices for Cleaning the Sand of Slow Sand Filters. E. M. Nichols. Brief descriptions of the methods and machines tried, and an illustrated description of the Nichols sand cleaning apparatus. 1500 w. Eng News—Sept. 30, 1909. No. 8208.

Ground Waters.

The Luzern Ground-Water Supply (Die Grundwasserfassung der Stadt Luzern in Thorenberg). V. Stirnimann. Describes a supply for a city of 36,000 inhabitants. Ills. 4500 w. Schweiz Bau—Aug. 28, 1909. No. 7970 B.

Illinois.

The Mineral Content of Illinois Waters. Edward Bartow, J. A. Udden, S. W. Parr, and George T. Palmer. Deals with the distribution, geographical classification, chemical properties, analyses, etc. 38000 w. Bul Univ of Ill—Sept. 15, 1908. No. 8147 N.

Irrigation.

Irrigation Works of the United States Government. Illustrates and describes the extensive works being constructed in the arid and semi-arid regions. 3000 w. Engr, Lond—Sept. 17, 1909. Serial. 1st part. No. 8133 A.

The Great Gunnison Irrigation Project. Albert Wilhelm. An illustrated brief description of the recently completed irrigation system of the Uncompahgre valley. 1200 w. Sci Am Sup—Sept. 18, 1909. No. 7804.

The Redemption of the Great Valley of California. A. D. Foote. Outlines a plan of basin irrigation and auxiliary works, similar to those used in the valley of the Nile, to protect from floods and store water for irrigation. Map. 6800 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8180 E.

See also Seepage, under WATER SUPPLY; Canals, under WATERWAYS AND HARBORS; and Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Pipe Corrosion.

The Rusting of Iron, and the Rochester, N. Y., Steel Conduit. This present article reviews recent researches introductory to a discussion of the practical side of the question. 3000 w. Engng—Aug. 27, 1909. Serial. 1st part. No. 7652 A.

Pipe Laying.

Cost of Laying Water Pipes. Gives cost in Boston and other Massachusetts cities, with analyses and comparisons of figures reduced to a common basis. 1800 w. Munic Jour & Engr—Sept. 1, 1909. No. 7510.

Pipe Lines.

The 72-Inch Steel Pipe Line of the Brooklyn Water Supply. Outlines the system of supply and gives an illustrated detailed description of the new line for additional supply, and its construction. 4500 w. Eng Rec—Sept. 18, 1909. No. 7814.

Financial and Sanitary Considerations in the Establishment of Water and Gas Pipe Lines (Etablissement des Canalisations d'Eau et de Gaz au Point de Vue des Intérêts financiers et sanitaires). M. J. Gilbert. Discusses the effects of leakage in pipe lines and describes the pipe joint invented by the author. Ills. 7000 w. Mem Soc Ing Civ de France—June, 1909. No. 7902 G.

Pipe Location.

Location of Pipes and Conduits for Public Service Corporations. Lewis M. Hastings. Gives the city ordinances of Cambridge, Mass., bearing on this subject. 2500 w. Jour Assn of Engng Socs—July, 1909. No. 7812 C.

Purification.

Water Supply and Purification. T. Aird Murray. Read before the Con. of Munic. of the Prov. of Saskatchewan. Discusses tuberculation and growths in water mains, their prevention and removal; and purification of water by mechanical filtration. 4500 w. Can Engr—Sept. 10, 1909. No. 7687.

The Toronto Water Purification Works. Illustrated detailed description of the general features. 1500 w. Eng Rec—Sept. 18, 1909. No. 7817.

Water Purification Plant of Toledo. Illustrated detailed description of the plant and its equipment. 4000 w. Munic Jour & Engr—Sept. 1, 1909. No. 7509.

Reservoirs.

The Outlet Control of Little Bear Valley Reservoir. F. E. Trask. Illustrated description of this feature of an important project in California. 1500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8185 E.

See also Ashokan, under WATER SUPPLY.

Roman Aqueducts.

Gage Measurements of Service Connections of the Ancient Roman Water-Works. M. L. Holman. Testimony to the arithmetical ability and the integrity of the records of the ancient hydraulic engineers. 1500 w. Jour Assn of Engng Socs—June, 1990. No. 7807 C.

Sedimentation Basins.

The Goderich Sedimentation Basin. J.

We supply copies of these articles. See page 323.

Grant MacGregor. Plan and sections of this basin, with description. 1500 w. Eng Rec—Sept. 4, 1909. No. 7560.

Seepage.

A Seepage Problem in Permeable Soil (Un Problema di Filtrazione di Acqua attraverso un Terreno permeabile). P. Alibrandi. A mathematical discussion of the rate of filtration of water from irrigation ditches. Ills. 4000 w. Ann d Soc d Ing e d Arch Ital—Aug. 15, 1909. No. 7942 F.

Sterilization.

The Practical Sterilization of Water and of Sewage Effluents. H. C. H. Shenton. Read at the Building Trds. Ex. Deals with practical methods of sterilization. 3500 w. Archt, Lond—Aug. 27, 1909. Serial. 1st part. No. 7633 A.

Tanks.

A Calculating Chart for the Contents of Cylindrical Tanks. Thomas B. Morley. Gives a chart by which the volume of liquid filling a cylindrical tank to any level may be found without arithmetical calculation. 2000 w. Engng—Sept. 3, 1909. No. 7748 A.

Watersheds.

Yield of Water, Rainfall, Etc., on a Moorland Watershed, and Notes on the New High-Level Water-Works of Exmouth. S. Hutton. Gives details of watersheds supplying Exmouth. 4000 w. Surveyor—Aug. 20, 1909. Serial. 1st part. No. 7429 A.

WATERWAYS AND HARBORS.

Buoys.

Aids to Navigation Near Belle Isle. P. E. Parent. Considers buoys, lighthouses, fog alarms, etc., as used in the Quebec District. Ills. 5500 w. Can Engr—Sept. 3, 1909. No. 7546.

See also Lightships, under MARINE AND NAVAL ENGINEERING.

Canals.

A Method for Determining the Most Economical Sections for Canals. A. L. Dabney. Diagrams constructed to show within what limits the ratio of bottom width to depth of flow may be varied without loss of economy and efficiency. Tables. 1000 w. Engng-Con—Sept. 15, 1909. No. 7798.

Abandoned Canals of the State of New York. Ely Van de Warker. An illustrated review, discussing the mistake of their abandonment. 2500 w. Pop Sci M—Sept., 1909. No. 7783 C.

Widening the American Canal at Sault Ste. Marie. Illustrated description of work in progress by the United States government. 3500 w. Eng Rec—Sept. 11, 1909. No. 7667.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XIe Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on combined navigation and irrigation canals. 16000 w. Ann d Ponts et Chaussées—1909-IV. No. 7915 E + F.

Dockyards.

See Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Dredging.

The Hydraulic Transmission of Dredged Materials at San Pedro Harbor, Cal.; A Record of Performance. H. Hawgood. Detailed description of methods used in filling and reclaiming submerged lands. Ills. 3300 w. Eng News—Sept. 2, 1909. No. 7535.

Dry Docks.

Floating Dry Docks for the Oregon Dry Dock Co. Drawings and details of construction of a medium-sized dock to meet stated conditions. Ills. 1000 w. Marine Rev—Sept., 1909. No. 7723.

12,000-Ton Pontoon Floating Dock for Kobe. Drawings and brief description of a recently completed dock for use in Japan. 300 w. Engr, Lond—Sept. 3, 1909. No. 7760 A.

Famagusta.

Famagusta Harbors, Cyprus. George Hobbs. Illustrated description of recent work for the improvement of this ancient port. 3000 w. Inst of Civ Engrs—No. 3782. No. 8160 N.

Finland.

See same title, under RAILWAY ENGINEERING, MISCELLANY.

Floods.

The Recent Floods at Monterey, N. L., Mexico. G. R. G. Conway. An illustrated report of a disastrous flood with record of rainfall. Editorial. 2200 w. Eng News—Sept. 23, 1909. No. 8016.

The Eger Flood and Ice Shove (Die Hochwasserkatastrophe und Eissprengen an der Eger im Postelberger Bezirke). Wenzel Werner. Illustrated description of the damage and of the temporary relief works. Ills. 2200 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 7, 1909. No. 7987 D.

Great Britain.

Railways and Waterways. G. R. Jebb. Report for Great Britain on the influence of waterways, considered as feeders and competitors of railways. 5500 w. Bul Int Ry Cong—Aug., 1909. No. 8028 G.

Lighthouses.

See Buoys, under WATERWAYS AND HARBORS.

Lock Gates.

The Lock Gates of the Panama Canal. Drawings and description. 1500 w. Eng News—Sept. 16, 1909. No. 7897.

New York.

The Water-Front of New York City. J. A. Bensel. Discusses the reasons for the municipalizing of the water-front and its development. 3500 w. Sch of Mines Qr—July, 1909. No. 7893 D.

We supply copies of these articles. See page 323.

Panama Canal.

Three Years in the Canal Zone. Dr. Summer Coolidge. An enthusiastic account of what has been accomplished. Also discussion. 7500 w. Jour Assn of Engng Socs—June, 1909. No. 7808 C.

The Panama Canal. Frederic P. Stearns. An account of observations made in a visit to the Isthmus in the early part of 1909. Ills. 6000 w. Jour Assn of Engng Socs—July, 1909. No. 7811 C.

The Present Aspects of the Panama Canal from the Tourist's Point of View. William Tatham. Explains present conditions, and the advantages of the plan adopted. 4500 w. Jour Fr Inst—Sept., 1909. No. 7885 D.

See also Lock Gates, under WATERWAYS AND HARBORS.

Pará.

The Trade of the Amazon, and the Port of Pará. David F. St. Clair. An illustrated article on the engineering and commercial opportunities in South America. 2500 w. Engineering Magazine—Oct., 1909. No. 8170 B.

St. Lawrence.

Improvements in the Navigation of the St. Lawrence. William P. Anderson. Read at Winnipeg meeting of the British Assn. Describes details of work to fit the river for the requirements of modern shipping. 3500 w. Engng—Sept. 17, 1909. No. 8129 A.

U. S. Waterways.

General Conditions of Transportation by Water in the United States. Extract from the report of the U. S. Commissioner of Corporations. Deals mainly with domestic traffic. 5000 w. Eng News—Sept. 9, 1909. No. 7629.

Water Powers.

Water-Power from Streams of Moderate Fall. Sylvester Stewart. An illustrated discussion of the utilization of hydraulic power resources. 1500 w. Cassier's Mag—Sept., 1909. No. 7781 B.

See also Finland, under RAILWAY ENGINEERING, MISCELLANY.

Wharves.

The Reinforced Concrete Wharf of the United Fruit Company at Bocas del Toro, Panama. T. Howard Barnes. Illustrated detailed description of the construction of a wharf in waters where the *Terodo navalis* is troublesome. 5700 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8184 E.

MISCELLANY.

Engineers' Fees.

Tariff of Compensation for Engineering and Architectural Work (Tariffa di Competenze per Lavori di Ingegneria e Architettura). Gives a schedule of the fees established by the Italian Society of Engineers and Architects. 2100 w. Ann d Soc d Ing e d Arch Ital—Aug. 1, 1909. No. 7941 F.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Bells.

Fitting Electric Bells. Clarence Biggs. Hints for amateur electricians. Ills. 3000 w. Sci Am Sup—Sept. 18, 1909. No. 7805.

Radiotelegraphy.

The Perry-Prentice Wireless Signalling System. H. Avery Blair. Illustrated description. 5000 w. Bul Int Ry Cong—Aug., 1909. No. 8031 G.

Radio-Telegraphy (Radiotelegrafie). A. E. R. Collette. A general review of modern achievements and developments. Ills. 10000 w. Ingenieur—Aug. 7, 1909. No. 8157 D.

Telephone Cables.

Principles of Fault Location. Julius Bernstein. Abstract of a paper read at the convention of Am. Munic. Elect'ns. Remarks confined to testing instruments based upon the principle of the Wheatstone bridge and methods of telephone practice. 3500 w. Elec Engr, Lond—Aug. 20, 1909. No. 7433 A.

Telephone Lines.

The Maximum Capacity of Telephone Lines (La Portée maximum des Lignes Téléphoniques). M. Devaux-Charbonnel. A theoretical discussion. Ills. Serial. 1st part. 4000 w. Tech Mod—Aug., 1909. No. 7927 D.

DISTRIBUTION.

Current Rectifiers.

A New Accumulator-Charging Apparatus. Illustrated description of the "Premier" rectifier, and the means of obtaining direct-current from an alternating supply. 1800 w. Auto Jour—Sept. 11, 1909. No. 7845 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Leakage Reactance. J. Rezelman. Deals with the leakage reactance of the stator windings of alternating-current machines, the rotors being removed. Ills. 2500 w. Elect'n, Lond—Aug. 20, 1909. Serial. 1st part. No. 7436 A.

The Operation of Alternators in Parallel. Joseph W. Anson. A detailed account of the writer's experience while controlling large alternating-current units running in parallel. 2000 w. Elect'n, Lond—Sept. 10, 1909. No. 7859 A.

We supply copies of these articles. See page 323.

A. C. Motors.

Types of Alternating-Current Commutator Motors and the Best Frequency for Railways. F. Eichberg. Investigates the influence of the frequency on the generators, transformers, transmission line, and more especially on single-phase commutator motors. 2500 w. Elect'n, Lond—Aug. 20, 1909. No. 7435 A.

New Five and Six-Speed Three-Phase Motor. Describes new design of the Maschinenfabrik Oerlikon. 2000 w. Elect'n, Lond—Aug. 27, 1909. No. 7646 A.

The Starting Torque of Three-Phase Motors, with Squirrel-Cage Rotors. Max Kloss. Aims to show the relations between the starting torque and the slip. 5000 w. Elect'n, Lond—Sept. 17, 1909. No. 8112 A.

Brushes.

See Lubrication, under DYNAMOS AND MOTORS.

Commutation.

Commutation in Continuous-Current Machines. H. E. Mellor. Explains the process of commutation in continuous-current machines. Ills. 3500 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8117 A.

Controllers.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

High-Voltage Dynamos.

High-Voltage Generators. Frank Koester. Illustrates and describes designs constructed and operated in Continental Europe. 1500 w. Elec Wld—Sept. 16, 1909. No. 7773.

Induction Motors.

Characteristics of the "Spinner" Motor. Selby Haar. Gives an explanation of arrangements for high and for low speed. 1200 w. Elec Wld—Sept. 6, 1909. No. 7774.

Lubrication.

Lubricating and Electric Brushes for Commutators and Collector Rings. E. O. Schweitzer. Describes a new type of lubricating brushes. Ills. 1200 w. Elec Rev, N Y—Sept. 18, 1909. No. 7838.

ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Actual State of the Cyanamide Industry (Etat actuel de la Fabrication de la Cyanamide). Robert Pitaval. Describes the process of manufacture, plants established, etc. Ills. 3500 w. Génie Civil—Aug. 21, 1909. No. 7936 D.

Electrolytic Assaying.

Apparatus for the Rapid Electro-Analytical Separation of Metals. H. J. D. Sand. Abstract of a paper before the Faraday Soc. Ilustrated description. 1200 w. Elect'n, Lond—Aug. 20, 1909. No. 7437 A.

Electro-Metallurgy.

Furnace Electrode Losses. C. A. Hansen. Gives interesting experimental data concerning the consumption of electrodes by oxidation. 1800 w. Elec-Chem & Met Ind—Sept., 1909. No. 7592 C.

Furnace Electrode Losses. Carl Hering. Gives results of a theoretical investigation. 3500 w. Elec-Chem & Met Ind—Sept., 1909. No. 7595 C.

Electro-Plating.

A Simple Method of Recovering Gold from Cyanide and Yellow Prussiate Plating Solutions. Describes a method in which the gold is precipitated on zinc shavings. 1400 w. Brass Wld—Sept., 1909. No. 7879.

Ozone.

The Production and Uses of Ozone (Sur la Production et les Usages de l'Ozone). Léon Gerard. Reviews the methods of production by electricity, its use in water purification, etc. Bibliography. Ills. 17000 w. Soc Belge d'Elecns—Aug., 1909. No. 7901 E.

Valve Electrodes.

Tungsten as "Valve" Electrode. L. H. Walter. A brief account of experiments made. 2000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8109 A.

ELECTRO-PHYSICS.

Arcs.

The Rotation of the Electric Arc in a Radial Magnetic Field. J. Nicol. Abstract of a paper read before the Roy. Soc. Experiments showing the speed of the arc to be independent of the arc length, to be proportional to the magnetic field strength, and to increase linearly with the current. 1000 w. Elect'n, Lond—Sept. 3, 1909. No. 7733 A.

Atomic Theory.

Prof. E. Rutherford's Address to Section A of the British Association. (Abstract.) Considers the present position of the atomic theory in physical science, and methods devised to determine the values of fundamental atomic magnitudes. 4500 w. Elect'n, Lond—Aug. 27, 1909. No. 7647 A.

Conductivity.

The Effect of Tension on Thermal and Electrical Conductivity. N. F. Smith. Abstract from *Phys. Rev.* Gives results showing that thermal conductivity of bars of iron, steel, copper, brass, etc., increased when a moderate tension was applied, whilst the electrical conductivity diminished. 1500 w. Elect'n, Lond—Sept. 3, 1909. No. 7734 A.

Electromagnets.

The Effect of Damping Windings on Direct-Current Magnet (Ueber die Wirkungsweise von Dämpferwicklungen auf Gleichstrommagneten). Karl Willy Wagner. Mathematical. Ills. Serial. 1st part.

We supply copies of these articles. See page 323.

4000 w. Elektrotech u Maschinenbau—Aug. 29, 1909. No. 7996 D.

Induction.

The Induction Law (Zum Induktionsgesetz). Fritz Emde. Discusses special cases of its application. Ills. 3500 w. Elektrotech u Maschinenbau—Aug. 22, 1909. No. 7994 D.

Some New Relations between the Factors which Serve to Express the Law of Electro-Magnetic Induction (Quelques nouvelles Relations entre les Facteurs qui Servent à Exprimer la Loi de l'Induction électro-magnétique). A. Mégroz. Mathematical. Ills. 3000 w. Bul Tech d l Suisse Romande—Aug. 10, 1909. No. 7930 D.

Magnetic Properties.

Influence of Arsenic and of Tin Upon the Magnetic Properties of Iron. Charles F. Burgess and James Aston. Submits results of investigations. 2200 w. Elec-Chem & Met Ind—Sept., 1909. No. 7596 C.

Magnets.

On the Self-Demagnetizing Factor of Bar Magnets. Silvanus P. Thompson. Abstract of a paper read before the Phys. Soc. Defines the term and reports experimental investigations. 1500 w. Elect'n, Lond—Sept. 10, 1909. No. 7861 A.

Mechanical Equivalent.

The Absolute Value of the Mechanical Equivalent of Heat, in Terms of the International Electrical Units. H. T. Barnes. Abstract of a paper before the Roy. Soc. Gives results of recent comparisons. 900 w. Elect'n, Lond—Aug. 20, 1909. No. 7438 A.

Radioactivity.

The Address of the President of the British Association. Editorial review of the address of Sir Joseph J. Thomson, dealing principally with radio-activity and allied phenomena. 3000 w. Engng—Aug. 27, 1909. No. 7655 A.

Studies of Electricity and Matter. Sir J. J. Thomson. Abstracted from the presidential address to the British Assn. for the Adv. of Science. A resumé of recent investigation. 4500 w. Sci Am Sup—Sept. 4, 1909. Serial. 1st part. No. 7562.

Progress in Electricity. Prof. Sir J. J. Thomson. Presidential address before the British Assn. for the Adv. of Science. An account of recent developments of physics, and the new conceptions of physical processes. 3000 w. Elec Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7644 A.

GENERATING STATIONS.

Accumulators.

The Requirements and Installation of Accumulator Rooms (Ueber die Eigenschaften und die Herstellung von Akkumulatoren-räumen). Brief general discussion. 2500 w. Elektrochem Zeitschr—Aug., 1909. No. 7948 D.

Central Stations.

General Considerations in the Design of Large Steam Central Stations (Notes sur les grandes Usines centrales à Vapeur au Point de Vue des Conditions generales de leur Etablissement). M. G. Chevrier. Discusses their location, layout, and design and arrangement of the steam and electrical equipment. 13000 w. Mem Soc Ing Civ de France—June, 1909. No. 7903 G.

Rise of Generator Capacity. Alton D. Adams. A record of the changes of generators in the electrical supply system of a large city, with a diagram showing the relation of time to their types, capacities and voltages. 1600 w. Elec Rev, N Y—Sept. 25, 1909. No. 8075.

The Efficiency of Electric Power Stations. Remarks on the losses in electric generating stations, and the possibility of securing more economical results. 1200 w. Engr, Lond—Aug. 27, 1909. No. 7660 A.

An Investigation of the Heat-Losses in an Electric Power-Station. Frank Huntington Corson. Describes a test made at the Blackburn generating-stations. Also abstract of discussion. Ills. 20500 w. Inst of Civ Engrs—No. 3765. No. 7162 N.

Oakland (Cal.) Steam Auxiliary Station for Great-Western Power Company. Describes the equipment apparatus installed. Ills. 1500 w. Elec Wld—Sept. 23, 1909. No. 8041.

A South American Gas-Engine-Driven Central Station. J. P. Stone. Illutsrated description of a gas power plant at Dolores, Argentine Republic. 2500 w. Elec Wld—Sept. 9, 1909. No. 7619.

A New Electrical Generating Station at Buenos Ayres. Illustrates and describes the large central station in course of construction. 2500 w. Engr, Lond—Sept. 10, 1909. No. 7868 A.

Electrical Development in Victoria. H. R. Harper. Abstract of presidential address before the Elec. Assn. of Victoria. 3000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8110 A.

Electrical Development in Victoria. H. R. Harper. Presidential address before the Elec. Assn. of Victoria. A review of the progress made in the use of electricity. 4500 w. Aust Min Stand—Aug. 4. 1909. No. 7635 B.

See also Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Economics.

Electric Power. Henry J. Gille, Presented at convention of the N. E. L. A. Analyzes the effect of various classes of power on station loads, and the advantage of obtaining power load that does not

come on the peak. 4000 w. Elec Age—Sept., 1909. No. 7840.

Notes on the Electrical Industry (Note sur l'Industrie de l'Energie électrique). A. Alby. A review of tendencies in the electrical industry, particularly the development of large distribution systems in Europe and America. Ills. 18500 w. Bul Soc d'Encour—July, 1909. No. 7917 G.

Hydro-Electric.

Injury to Water-Power Plants by Municipal Water-Works. Gives a recent decision of the Michigan Supreme Court in a case. 2500 w. Eng Rec—Sept. 11, 1909. No. 7673.

Hydro-Electric Power in Canada. Discussion of the paper by Cecil B. Smith. Ills. 1500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8186 E.

Electrical Equipment of the Great Western Power Company. Illustrates and describes interesting details of the electrical part of the equipment. 1800 w Elec Wld—Sept. 16, 1909. No. 7772.

The Construction of the Hydro-Electrical Developments at Kilbourn, Wisconsin. Illustrated detailed description of the construction plant and methods which are quite out of the ordinary. 4000 w. Eng Rec—Sept. 18, 1909. No. 7815.

The Hydro-Electric Development of the Southern Wisconsin Power Company. Illustrated detailed description of a long-distance transmission from a plant near Kilbourn, Wis. 6000 w. Eng Rec—Sept. 4, 1909. No. 7555.

Combination System of the Hydro-Electric & Gas Company of Warren, Ohio. Illustrates and describes a system uniting a number of water-powers of various heads, at scattered points, into a single system, delivering the energy where a steam engine and gas-engine auxiliary are used on the same system, all operating in parallel. 4000 w. Elec Wld—Sept. 2, 1909. No. 7526.

Vernon, Vt., Hydroelectric Development. C. E. Bascom. Illustrated description of large water-power plant with three rotor vertical turbines designed for 30-ft. head and opertation under extremes of water level. 1500 w. Power—Sept. 28, 1909. No. 8142.

Hydro-Electric Development of the Connecticut River Power Company. Illustrated description of a plant and transmission line serving a number of towns and cities. 1800 w. Elec Wld—Sept. 9, 1909. No. 7620.

The Marklissa Dam and Hydro-Electric Power Plant. C. Bachmann. Abstract translation from *Zeit. für Bauwesen*. Brief illustrated description of the river regulation and power development works. 1500 w. Eng Rec—Sept. 25, 1909. No. 8065.

The Hydro-Electric Power Plant at Svalgfos, Norway. Translation of article by S. Eyde and Kloumann in the *Zeitschrift* of the Soc. of German Engrs. Illustrated detailed description. 5400 w. Eng Rec—Sept. 11, 1909. No. 7670.

A Hydro-Electric Installation in Nyassa-Land. Alexander Spence Chalmers. Illustrated description of a plant of simple construction to be operated by skilled native labor. 1600 w. Inst of Civ Engrs. No. 3789. No. 8163 N.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Electric Power in the Works of Messrs. Armstrong, Whitworth & Co., Ltd., Manchester. Illustrated detailed description of plant installed for these engineering works. 3500 w. Elec Rev, Lond—Sept. 10, 1909. Serial. 1st part. No. 7857 A.

See also Mechanical Plants, under MECHANICAL ENGINERING, POWER AND TRANSMISSION.

Netherlands.

Statistics of Electric Central Stations in the Netherlands (Statistiek van Centraal Stations voor Elektrische Stroomlevering in Nederland). Gives details of each station. 5000 w. Ingenieur—Aug. 28, 1909. No. 8159 D.

Rates.

The Price of Electricity. William D. Marks. An explanation of the Marks' sliding scale. 3500 w. Elec Wld—Sept. 2, 1909. No. 7531.

LIGHTING.

Arc Lamps.

The Economy of New High-Intensity Light Sources (Wesen und Wirtschaftlichkeit neuerer elektrischer Starklichtquellen). P. Heyck. A discussion of the flaming arc lamp and the quartz lamp. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7999 D.

Illumination.

The Work of the Illuminating Engineer. Donald Cameron Shafer. Reviews the achievements of illuminating engineering. Ills. 5000 w. Am Rev of Revs—Sept., 1909. No. 7785 N.

Design of Illuminating Installations Using Luminous Tubes. M. D. Cooper. A discussion of the relation existing between the rated candle-power of a tube lamp and the illumination upon a plane lighted by it. 3000 w. Elec Wld—Sept. 23, 1909. No. 8044.

The Effect of Various Maintenance Conditions on the Efficiency of Illumination. A. L. Eustice. Gives results of a recent study of commercial systems with special reference to this subject. 2500 w. Elec Age—Sept., 1909. No. 7842.

We supply copies of these articles. See page 323.

Spacing of Light Units. Alfred A. Wohlauer. Discusses relations of importance in connection with the spacing of light sources. 2000 w. Elec Wld—Sept. 16, 1909. No. 7775.

Luminosity.

Luminosity and Temperature. P. G. Nutting. An outline of the equations thus far developed and the most reliable constants that have been ascertained by careful investigation. 2000 w. Elec Wld—Sept. 23, 1909. No. 8043.

Mercury Arc.

White Light from the Mercury Arc and Its Complementary. Herbert E. Ives. A record of experimental investigations of the proper light source to be combined with the mercury arc to imitate average daylight. 2000 w. Elec Wld—Sept. 23, 1909. No. 8042.

Photometry.

An Experimental Study of the Globe Photometer. A. A. Perrine. Report of a study made in the laboratories of Armour Inst., Chicago. 1500 w. Elec Wld—Sept. 23, 1909. No. 8045.

Street.

Street Lighting for Small Towns. J. R. Cravath. Deals principally with towns of 15000 population, or less. 4500 w. Elec Wld—Sept. 2, 1909. No. 7527.

Street-Lighting Conditions in Boston. An illustrated account of tests made and methods adopted under the contract of the Edison Electric Illuminating Co. 3500 w. Elec Wld—Sept. 2, 1909. No. 7528.

Transformers.

Metallic-Filament Lamp Transformers. L. Crouch. Deals with considerations regarding their technology and economics. Ills. 2000 w. Elec Rev, Lond—Sept. 3, 1909. Serial. 1st part. No. 7727 A.

MEASUREMENT.

Instruments.

Electrical Measuring Instruments for Direct Current and Their Use. R. M. Phinney. Discusses the measurement of pressure, current, resistance, and power. 3000 w. Sig Engr—Sept., 1909. No. 7828.

Insulation.

The Measurement of the Insulation of a Live Three-Wire System. Stuart A. Russell. Describes Prof. Rousseau's method. 500 w. Elec Rev, Lond—Sept. 17, 1909. No. 8111 A.

Laboratories.

Electrical Work at the Physikalisch-Technische Reichsanstalt in 1908. Gives a summary of the work in the electrical department during the year. 2000 w. Elect'n, Lond—Aug. 27, 1909. No. 7648 A.

Meters.

The Performance of Electricity Meters under Fluctuating Load (Ueber das Verhalten von Elektrizitätszählern bei schwankender Belastung). E. Orlich and Günther-Schulze. Shows that fluctuations in load have no effect on the accuracy of the meter. Ills. 2000 w. Elektrotech u Maschinenbau—Aug. 29, 1909. No. 7995 D.

Slip.

The Asynchronometer, a New Machine for Measuring Slip (Das Asynchronometer, ein neuer Schlüpfungsmesser). Felix Horschitz. Illustrated description of its construction and use. 2200 w. Elek Kraft u Bahnen—Aug. 24, 1909. No. 7991 D.

POWER APPLICATIONS.

Steel Works.

See same title, under MINING AND METALLURGY, IRON AND STEEL.

TRANSMISSION.

Alternating Current.

Charts for the Calculation of Alternating Current Circuits. H. P. Liversidge. Gives charts and describes their use for the solution of various problems. 1000 w. Power—Sept. 14, 1909. No. 7721.

Cables.

The Distribution of Dielectric Stress in Three-Phase Cables. W. M. Thornton and O. J. Williams. Read before the Engng. Sec. of the British Assn., at Winnipeg. Gives a solution of the problem of finding the voltage gradient at any point in the cross-section of a three-core cable for three-phase currents, at any time during the cycle of electrification. 3500 w. Engng—Aug. 27, 1909. No. 7657 A.

The Calculation of Charging Currents in Three-Phase Cables. Prof. E. W. Marchant. Read before the British Assn., at Winnipeg. Considers the determination of the capacity current flowing into a three-phase line. 1000 w. Elect'n, Lond—Sept. 3, 1909. No. 7731 A.

Electric Cables (Cables électriques). Victor Lebeau. Graphical charts for determining the size of cables for d. c. and a. c. transmission, the heating under certain conditions, etc. Ills. 2500 w. All Indus—Aug., 1909. No. 7931 D.

Conduits.

See Pipe Location, under CIVIL ENGINEERING, WATER SUPPLY.

Grounded Neutral.

Earthing the "Neutral" of Three-Wire Systems. Considers the extent to which the main should be earthed, the object, and the calculations regarding neutral earthing conductors. 2500 w. Elec Rev, Lond—Sept. 10, 1909. No. 7858 A.

Line Construction.

High-Tension Aerial Transmission Lines (Ueber Hochspannungsfreileitungen). Ludwig Kallir. A comparative study of the Austrian, German, French and Swiss regulations for their safe construction. Ills. Serial. 1st part. 6000 w. Zeit d Oest Ing u Arch Ver—Aug. 27, 1909. No. 7986 D.

Losses.

Atmospheric Loss Off Wires Under Direct-Current Pressures. E. A. Watson. Read before the British Assn., at Winnipeg. A report of tests made at the electrical engineering laboratories of the Univ. of Liverpool. 4000 w. Elect'n, Lond—Sept. 3, 1909. No. 7732 A.

Three-Wire.

See Insulation, under MEASUREMENT.

Transformers.

Relations Between Output, Losses, Dimensions, Weight and Cost of Transformers. E. G. Reed. Deals with the effect of changing the design proportions. 2500 w. Elec Wld—Sept. 9, 1909. No. 7622.

The Design of Shell-Type Transformers. Roger P. Heller. Suggestions concerning methods that may be employed in selecting the final dimensions. 1200 w. Elec Wld—Sept. 9, 1909. No. 7621.

See also same title, under LIGHTING.

Wire Specifications.

The New Specification for Hard Drawn Copper Wire. Edward N. Lake. Comments on the proposed standard specifications of the Am. Soc. for Test. Materials; from the standpoint of the purchaser's engineer, with special reference to wire and cable for electric railway use. 1800 w. Elec Ry Jour—Sept. 18, 1909. No. 7793.

MISCELLANY.

Accidents.

Fires and Accidents in Electrical Installations. H. S. Knowlton. Considers some causes of troubles. 1800 w. Power —Sept. 7, 1909. No. 7598.

Aluminium.

Aluminium in Transmission Lines (Emploi de l'Aluminium pour l'Etablissement des Canalisations électriques). J. A. Montpellier. Discusses the production of aluminium and its physical properties, and enumerates the important aluminium transmission lines in existence. Ills. 3200 w. Elecn—Aug. 14, 1909. No. 7929 D.

Calculating Devices.

The Arthur Wright Electrical Device for Evaluating Formulae and Solving Equations. Alexander Russell and Arthur Wright. Abstract of paper before the Phys. Soc. Describes a device combining the principle of the ordinary logarithmic slide rule with addition and subtraction. 1600 w. Elect'n, Lond—Sept. 17, 1909. No. 8114 A.

Electrical Industry.

The National Electrical Code and the Relation of the Contractor to the Central Station. W. H. Blood, Jr. Read before the Nat. Elec. Con. Assn. A brief discussion of the importance of each in the development of the electrical industry. Also editorial. 3500 w. Cent Sta—Sept., 1909. No. 7686.

Standardization.

International Electrical Standardization. Ormond Higman. Abstract of paper read before the Engng Soc. of the British Assn. at Winnipeg. Discussing the general organization and the aims and objects of this movement. 4500 w. Engng —Sept. 17, 1909. No. 8128 A.

INDUSTRIAL ECONOMY.

Cost Systems.

See Cost Keeping, under CIVIL ENGINEERING, CONSTRUCTION.

Education.

The Rev. H. B. Gray's Address to the Educational Science Section of the British Association. (Abstract.) Discusses the educational factors of Imperialism. 3000 w. Elect'n, Lond—Sept. 3, 1909. No. 7730 A.

Why Manufacturers Dislike College Graduates. Frederick W. Taylor. Condensed report of Mr. Taylor's discussion of a paper on engineering education. 3500 w. Elec Jour—Sept., 1909. No. 7572.

Three Years of the Coöperative Courses. Herman Schneider. Reports the satisfactory operation of these engineering courses at the University of Cincinnati. 4000 w. Am Mach—Vol. 32. No. 36. No. 7700.

The New Engineering Laboratories and Workshops at the Heriot-Watt College, Edinburgh. Illustrations and descriptions of these new buildings in Edinburgh, and their equipment. 2000 w. Engng—Aug. 20, 1909. No. 7442 A.

The Employment of Models to Illustrate Important Mechanical Principles in Engineering Education (Die Verwendung von Modellen zur Veranschaulichung wichtiger Sätze der technischen Mechanik im Hochschulunterricht für Maschineningenieure). Eugen Meyer. Ills. Serial 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1909. No. 8150 D.

The Development of Higher Technical Education in France (L'Orientation des Programmes de l'Enseignement supérieur technique en France). Edmond Dayras. A review of the tendency to introduce economic courses. 4000 w. Génie Civil —Aug. 21, 1909. No. 7938 D.

Engineering Ethics.

The Ethics of the Engineering Profession. Benjamin B. Lawrence. Considers

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some of the questions that arise in the profession of mining engineering. 1500 w. Sch of Mines Qr—July, 1909. No. 7894 D.

Engineering Profession.

President's Address at the 41st Annual Convention of the American Society of Civil Engineers, Bretton Woods, New Hampshire. July 6, 1909. Onward Bates. Discusses "The Status of the Civil Engineer's Profession in the United States of America." 4500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8149 F.

Presidential Address before the Engineering Section of the British Association at Winnipeg. Sir W. H. White. Deals principally with the service engineers have rendered in the development of Canada. 10500 w. Can Engr—Sept. 3, 1909. No. 7547.

Expositions.

The International Exposition at Nancy, 1909 (L'Exposition internationale de Nancy, 1909). A. Bidault des Chaumes. Describes interesting features of buildings and exhibits. Ills. 7200 w. Génie Civil —Aug. 7, 1909. No. 7932 D.

The Nancy Industrial Exposition, 1909 (Die Industrieausstellung in Nancy, 1909). Describes particularly the exhibits relating to the iron and steel industry. Ills. 3000 w. Stahl u Eisen—Aug. 18, 1909. No. 7952 D.

Filing Systems.

Filing and Indexing Data in the Office of the Chief Engineer of Elevated and Subway Construction, Boston Elevated Railway Company. Herbert C. Hartwell. Outlines the system of numbering, filing, and indexing data. 1200 w. Jour Assn of Engng Socs—Aug., 1909. No. 8061 C.

An Efficient Indexing System for a Civil Engineer's Office. Walter A. Brown. Describes a system evolved by the writer, similar in some respects to the decimal system designed by W. G. Taylor. 1500 w. Eng News—Sept. 2, 1909. No. 7538.

The Filing System of Records in the Engineering Department of Salt Lake City. O. H. Skidmore. An expalnation of the system. 2000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8059 C.

Indexing Used in the Engineering Department of the Town of Brookline, Mass. Henry A. Varney. Describes a system devised in 1902 and still used. 1000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8060 C.

A Specification for Filing and Indexing Railroad Plans. Herman K. Higgins. Outlines a system simple enough to allow of its use by unintelligent help and of wide adaptability. 5500 w. Jour Assn of Engng Socs—Aug., 1909. No. 8058 C.

Finland.

The Development of the Industries of Finland. The first of a series of articles on the recent rapid development of Finland industries, reviewing earlier history. 4000 w. Engr, Lond—Sept. 3, 1909. Serial. 1st part. No. 7756 A.

Labor Insurance.

Contributions to the Operation of the Accident Insurance System and the Fixing of Risks and Premiums (Die Beiträge der Betriebe zur Unfallversicherung und das Gefahrentarifwesen). Konrad Hartmann. Discusses the operation of the German system of labor insurance. 3500 w. Tech u Wirt—Aug., 1909. No. 8153 D

Management.

Organization by Production Factors. A. Hamilton Church. This part of a series of articles on production costs, considers factors other than labor. 4500 w. Engineering Magazine—Oct., 1909. No. 8171 B.

The Importance of System in Manufacturing Enterprises. Oscar E. Perrigo. Shows the necessity of system, discussing conditions to be considered and giving helpful suggestions. 5500 w. Ir Trd Rev —Sept. 9, 1909. No. 7677.

Natural Resources.

The Conservation Controversy. Herman B. Walker. A critical review of the movement in the United States. 5000 w. Power—Oct. 5, 1909. No. 8320.

President Taft on Conservation and the Work of the Reclamation Service. From an address delivered at Spokane, Wash., explaining the policy of the administration. 2200 w. Eng News—Oct. 7, 1909. No. 8406.

Production and Waste of Mineral Resources. J. A. Holmes. A brief consideration of the production, consumption and waste in the United States, and the prevention of the waste. 4500 w. Min Wld—Oct. 2, 1909. No. 8313.

Pension Systems.

A Pension System Embracing all Classes of Labor (Un Système de Réalisation possible de Retraites pour tous les Travailleurs). Léon Dargouge. Suggests an old-age pension system applicable to conditions in France. 3500 w. Rev d'Econ Indus—Aug. 16, 1909. No. 7900 D.

Siberia.

Siberia. Henry G. Read. Reviews the industrial and commercial resources of northern Asia. Ills. 5500 w. Cassier's Mag—Sept., 1909. No. 7776 B.

Standardization.

Standardization and Its Influence on Engineering Industries. William Cawthorne Unwin. The substance of two lectures before students of the Inst. of Civ. Engrs. Discusses what is required, the advantages, etc. Ills. 14000 w. Inst of Civ Engrs—Vol. CLXXVII. Part III. No. 8164 N.

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MARINE AND NAVAL ENGINEERING.

Armorclads.

The First Sea-Going Armorclads. An illustrated account of the rapid development of armorclad vessels, the first having been built only about fifty years ago. 4000 w. Int Marine Engng—Sept., 1909. No. 7615 C.

Battleships.

U. S. S. Michigan. William Ashley Leavitt, Jr. Illustration with description and report of official trials. 11800 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8095 H.

"Clermont."

The Clermont. Brief Illustrated description of Robert Fulton's steamboat, built in 1807. 800 w. Int Marine Engng—Sept., 1909. No. 7608 C.

Fulton and the Clermont. W. P. Stephens. An illustrated review of Fulton's life and the building of the Clermont. 2800 w. Rudder—Sept., 1909. No. 7689 C.

The "Half Moon" and the "Clermont." E. A. Dixie. Illustrated descriptions of Henry Hudson's "Half Moon" and Fulton's "Clermont." Describing the engine and boiler of the "Clermont." 2000 w. Am Mach—Vol. 32. No. 37. No. 7768.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Colliers.

United States Fleet Colliers Vestal and Prometheus. Drawings and description. 700 w. Marine Rev—Sept., 1909. No. 7724.

Cruisers.

The French Armored Cruiser Ernest Renan. Illustrated detailed description of the largest vessel of her type in the French navy. 3000 w. Engr, Lond—Sept. 3, 1909. No. 7757 A.

Dredges.

Simons' Clay-Cutting Reclamation Dredges. Illustrates and describes powerful dredgers used in the Port of Bombay, with report of their work. 1500 w. Engng—Sept. 3, 1909. No. 7749 A.

Electric Power.

Turbo-Electric Propulsion for Vessels. R. M. Neilson. Examines the advantages and disadvantages of the turbo-electric drive on shipboard. 2500 w. Cassier's Mag—Sept., 1909. No. 7778 B.

Electrical Propulsion of Ships. William P. Durtnall. Abstract of a paper before the London Assn. of Foremen, Engineers, and Draughtsmen. Reviews the history of development in applying the electric motor to ship propulsion, showing the saving in fuel possible. 2500 w. Elec Engr, Lond—Sept. 10, 1909. No. 7856 A.

Electrical Installations on Steamships. H. T. Boothroyd. Read before the Liverpool Engng. Soc. Explains the difficulties to be overcome and the special features, wiring practice, etc. 3500 w. Mech Wld—Aug. 20, 1909. Serial. 1st part. No. 7432 A.

Extended Uses of Electricity on Board Ship. John McLaren. Abstract of paper before the Inst. of Marine Engrs. Shows the great saving that can be affected by installing a suction-gas plant and alternator for supplying electrical energy for operating the auxiliaries. 9000 w. Elec Engr, Lond—Sept. 10, 1909. No. 7855 A.

Explosives.

The Propulsive Energy of Explosives. Sir Andrew Noble. Presented at joint meeting of Inst. of Engrs. & Shipbldrs., and the N-E Coast Engrs. Gives a sketch of the history of propellants, discussing the old gunpowders, and the modern propellants. 3000 w. Mech Engr—Sept. 10, 1909. No. 7853 A.

Ferry Steamers.

The Danish Railway Ferry "Prins Christian." Illustrated description of this large steel steamer and its equipment. 1500 w. Engng—Sept. 10, 1909. No. 7865 A.

Fishing Boats.

The East Coast Auxiliary Drifter "Sardius." Illustrated description of a fishing boat, fitted with a paraffin-motor. 1000 w. Engng—Aug. 20, 1909. No. 7443 A.

Fuel Contracts.

The Choice and Control of Fuel Supplies by Steamship Companies. John B. C. Kershaw. Aims to show how the customary clause in steamship companies fuel contracts can be replaced by one affording greater protection. 2000 w. Engr, Lond—Aug. 20, 1909. No. 7483 A.

Fulton.

Fulton and His Life Work. An illustrated review. 3300 w. Sci Am—Sept. 25, 1909. No. 8076.

Robert Fulton's Contributions to the Success of Steam Navigation. Edward Hageman Hall. Extracts from a brief history of Henry Hudson and Robert Fulton published by the Hudson-Fulton Celebration Commission. 3000 w. Eng News—Sept. 16, 1909. No. 7898.

Gas Engines.

Marine Producer Gas Power. Discussion of C. L. Straub's paper. 2000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8099 F.

Grain Elevators.

A Novel Cantilever Grain Elevator. Illustrated description of a novel design

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by Alfred H. Mitchell, and its operation in discharging grain from a ship's hold to other craft. It is of the self-propelling pontoon contained type. 2000 w. Sci Am —Sept. 11, 1909. No. 7630.

"Great Eastern."

The Great Eastern. Gives illustrated description and reviews the history of this large vessel. 2000 w. Int Marine Engng —Sept., 1909. No. 7617 C.

"Half Moon."

The Half Moon. An illustrated article discussing the design of this vessel, and giving detailed description. 3500 w. Rudder—Sept., 1909. No. 7690 C.

The Half Moon. Brief illustrated description of the vessel which brought Henry Hudson into New York harbor three hundred years ago. 1200 w. Int Marine Engng—Sept., 1909. No. 7610 C.

Hendrick Hudson's Half Moon Reproduced. Illustrations and information concerning this vessel of the early part of the 17th century. 1200 w. Naut Gaz—Sept. 2, 1909. No. 7449.

Hydroplanes.

Hydroplanes or Skimmers. Sir John Thornycraft. Read before the Engng. Sec. of the British Assn. at Winnipeg. A report of the writer's experiments, illustrating models used. 2200 w. Engng—Sept. 3, 1909. No. 7751 A.

Ice Breakers.

The Canadian Ice-Breaker "Earl Grey." Illustration with description. 800 w. Engng—Sept. 17, 1909. No. 8126 A.

Launching.

Launching Calculations. John Smith. Read before the Inst. of Nav. Archts. On launching calculations with special reference to the effect of camber. 3500 w. Engng—Aug. 20, 1909. No. 7446 A.

Lightships.

Unwatched Flashing Gas-Lighted Boat. Illustrated description of a small lightship and its optical apparatus on trial on the English coasts. 1800 w. Engr, Lond —Aug. 27, 1909. No. 7661 A.

Marine Transport.

Recent Progress in Ocean Transportation and Ship Propulsion. Sir William H. White. Extracts from presidential address before the British Assn. for the Adv. of Science. 4000 w. Eng News—Sept. 23, 1909. No. 8018.

Fishguard and the Atlantic Service. Editorial on the service undertaken by the Cunard Line in connection with the Great Western Ry. 2000 w. Engng—Sept. 3, 1909. No. 7752 A.

Oil Engines.

See Fishing Boats, under MARINE AND NAVAL ENGINEERING.

Paddle Boats.

Pioneer Paddle-Boats in Britain. G. Pinhorne. Illustrates and describes early types, tracing the development. 2500 w. Int Marine Engng—Sept., 1909. No. 7611 C.

Propellers.

The First Steam Screw Propeller Boat. Abstract of an article by Francis B. Stevens in the *Stevens Indicator*. Describes the steam screw propellers of Col. John Stevens, in operation on the Hudson River from 1802 to 1806. 1500 w. Int Marine Engng—Sept., 1909. No. 7612 C.

Ship Propulsion by Radial Reaction Propeller (Antrieb von Schiffen mittels radialen Reaktionspropellers). Herr Euler. Describes and discusses the system. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1909. No. 7977 D.

The Flow of Fluids along Surfaces (Sur l'Ecoulement des Fluides de Long des Surfaces). A. Rateau. An outline of the author's propeller theory, which is applied to aeroplanes. Ills. 4500 w. Rev de Mécan—Aug., 1909. No. 7925 E + F.

Fluid Pressure on Inclined Planes. Editorial review of recent experiments by Prof. Rateau. 2000 w. Engng—Sept. 17, 1909. No. 8125 A.

Repair Ships.

Description of the Foundry on the Vermont and Its Work. W. B. Tardy. A general description of the foundry installed and operated by the ship's force. 1000 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8089 H.

Sailing Vessels.

The Development of the Sailing Ship. Sidney F. Walker. An illustrated historical review. 4500 w. Int Marine Engng—Sept., 1909. No. 7609 C.

Salvage.

A Novel Salvaging Operation. Illustrated account of the methods used to bring the "Netherton," injured by an explosion, from Singapore to England. 800 w. Sci Am Sup—Sept. 11, 1909. No. 7631.

Steel Lifting Lighters. Illustrations and brief description of large lighters for salvage purposes. 350 w. Engng—Aug. 20, 1909. No. 7445 A.

Shipbuilding.

The New Vulcan Dockyard of the Stettin Company at Hamburg (Die neue Werft der Stettiner Maschinenbau-A.-G. Vulcan in Hamburg). Paul Ranft. Illustrated detailed description. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 21, 1909. No. 8154 D.

The Steel-Sections Problem in the German Shipbuilding Industry (Die Profilfrage im deutschen Handelsschiffbau). Carl Kielhorn. A discussion of possible improvements in the structural-steel sections available for shipbuilding purposes in Germany. Ills. Serial. 1st part. Schiffbau—Aug. 11, 1909. No. 7966 D.

See also Cranes, under MECHANICAL ENGINERING, TRANSPORTING AND CONVEYING.

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Ship Design.

Corrugated System of Ship Construction. Brief illustrated description of the "Monitoria," built on this system, which increases the longitudinal strength. 350 w. Sci Am—Oct. 2, 1909. No. 8211.

The Number of Shafts for Turbine Vessels. An investigation of the governing factors which decide the number of propelling shafts. 4500 w. Engng—Sept. 24, 1909. No. 8360 A.

Ships' Stability.

A Short Method of Determining the Longitudinal Stability of Ships (Abgekürztes Verfahren zur Bestimmung der Längsfestigkeit von Schiffen). Alfred Schmidt. Mathematical demonstration. Ills. Serial. 1st part. 2800 w. Schiffbau—Aug. 11, 1909. No. 7968 D.

Steamboats.

European Steamboats Prior to the "Clermont." Illustrated review. 1600 w. Sci Am—Sept. 25, 1909. No. 8079.

American Steamboats Prior to the "Clermont." Brief illustrated descriptions of boats of Rumsey, Fitch, and Stevens, with a summary of other efforts. 3000 w. Sci Am—Sept. 25, 1909. No. 8078.

Development of the Hudson River Steamboat. A review of the development, illustrating types of vessels and giving interesting information. 3500 w. Sci Am—Sept. 25, 1909. No. 8077.

The Development of Western River Steamboats. T. M. Rees. Illustrations and descriptions of typical boats used since 1811. 2000 w. Int Marine Engng—Sept., 1909. No. 7613 C.

See also Paddle Boats, under MARINE AND NAVAL ENGINEERING.

Steam Boilers.

The Treatment of Marine Boilers. H. Ruck-Keene. Read before the Inst. of Marine Engrs. Discusses some of the causes of boiler failures and the treatment that will remedy the troubles. 4000 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8120 A.

Steam Engines.

The Engine of Fulton's Clermont. Gives model of the engine and history relating to it. 1000 w. Ir Age—Sept. 23, 1909. No. 8000.

The American Walking-Beam Engine. Illustrated description of the engine that has been the favorite for Hudson River steamboats. 2000 w. Sci Am—Sept. 25, 1909. No. 8080.

Marine Engine Repairs Under Way. E. C. Kalbfus. Describes repairs made to an engine of the *Kansas*, while with the fleet on its journey around the world. Ills. 2000 w. Pro U S Nav Inst—Sept., 1909. No. 8056 F.

Steaming Competition.

Naval Engineering Competition. H. C. Dinger. Concerning the system of engineering competition established in the U. S. Navy and the good results expected from the contests. 4000 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8091 H.

Steamships.

Norddeutscher-Lloyd Twin Screw Steamer "George Washington." Illustrated detailed description of this large vessel and its equipment. Plate. 4500 w. Engng—Aug. 27, 1909. No. 7654 A.

The Steam Collier "Pallion." Illustrated description of a collier equipped with twin-belt conveyors for discharging her cargo. 500 w. Engng—Aug. 27, 1909. No. 7656 A.

A New Swedish Ore Vessel. Illustrated description of the Vollrath Thans, which carries its own unloading plant. 1000 w. Ir Age—Oct. 7, 1909. No. 8374.

The Italian Passenger and Emigrant Steamer "America." Illustrated description of a vessel designed for the River Plate service. Only first and third class passengers are carried. Plate. 1000 w. Engng—Sept. 24, 1909. No. 8361 A.

Steam Turbines.

Some Notes on Parsons Turbine Construction. A. B. Willits. Illustrations of the turbine of the *Preston*, with a study of details of construction. 6000 w. Pro U S Nav Inst—Sept., 1909. No. 8055 F.

Modern Turbine Installations in War Vessels. G. Bauer. Illustrates and describes the turbine systems installed and considers points in the preparation; discussing steam consumption, etc. Also discussion by Director Boveri. 12800 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8088 H.

Upkeep of the Parsons Marine Steam Turbines of the U. S. S. Chester. A. F. H. Yates. Reviews the history of the turbines to show the reasons for conditions, describing the repairs. Ills. 4500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8094 H.

Submarines.

General Considerations in the Design of Submarines (Allgemeine Gesichtspunkte für Entwurf von Unterseebooten). K. Dietze. The first part gives details of existing and projected submarines of all navies. Ills. Serial. 1st part. 2800 w. Schiffbau—Aug. 11, 1909. No. 7967 D.

"Victory."

Nelson's Flagship Victory. G. Pinhorne. Illustrated detailed description and historical account. 4000 w. Int Marine Engng—Sept., 1909. No. 7616 C.

Warships.

Early War Steamers. Illustrates and describes the early steam-propelled vessels engaged in warfare. 2500 w. Int Marine Engng—Sept., 1909. No. 7614 C.

Recent Warship Development. Benjamin Taylor. Reviews the output of British shipyards since 1907. 2000 w. Int Marine Engng—Sept., 1909. No. 7618 C.

We supply copies of these articles. See page 323.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Acetylene Generators.

Points on the Care of Acetylene Generators. Suggestions concerning their practical management. Ills. 1600 w. Auto Jour—Sept. 11, 1909. Serial. 1st part. No. 7846 A.

Carburettors.

Novelty in Carburettor Design. Illustrated detailed description of the "Polyrhoe" expanding carburettor. 4500 w. Auto Jour—Sept. 18, 1909. No. 8107 A.

Cottin-Desgouttes.

The 22 h. p. Cottin-Desgouttes Car. Illustrated detailed description of this French built car. 1400 w. Autocar—Aug. 21, 1909. No. 7425 A.

De Dion.

The 12-14 h. p. Four-Cylinder De Dion Car. Illustrated description of a model designed after general De Dion practice. 1800 w. Autocar—Sept. 11, 1909. No. 7847 A.

Design.

Progress in Car Design. Some illustrated notes of the mechanical details of the historical cars at Shepherd's Bush. 1600 w. Autocar—Sept. 18, 1909. No. 8105 A.

Electric Batteries.

Management of Electrical Vehicle Batteries. H. M. Beck. Read at meeting of Soc. of Auto. Engrs. Suggestions and instructions for those in charge of the operation and upkeep of electric vehicles. 2500 w. Com Veh—Sept., 1909. Serial. 1st part. No. 7496 C.

See also Current Rectifiers, under DISTRIBUTION.

Fire Engines.

Development of the Gas Motor Fire Engine. An illustrated article describing details of some recent machines. 2500 w. Com Veh—Sept., 1909. No. 7495 C.

A German Automobile Fire Engine. Illustrated description with report of experiments in Frankfort. 1200 w. Sci Am Sup—Sept., 25, 1909. No. 8081.

Germain.

A Small 6-Cylinder Car from Belgium. Illustrates and describes the leading features of the 20 h. p. Germain. 900 w. Auto Jour—Sept. 11, 1909. Serial. 1st part. No. 7844 A.

Holsman.

Holsman High-Wheelers for 1910. Illustrates several types and describes the driving mechanism. 2000 w. Automobile—Sept. 9, 1909. No. 7706.

Ignition.

Some Hints on Ignition Testing. C. Wadsworth. Illustrates and describes the Hoyt voltammeter, explaining how it simplifies ignition testing. 2500 w. Automobile—Sept. 16, 1909. No. 7796.

How a Magneto Makes Electricity. P. S. Tice. An illustrated explanation of the principles involved and the method of operation in the production of ignition sparks in the modern magneto. 2000 w. Autocar—Aug. 28, 1909. Serial. 1st part. No. 7639 A.

Laboratories.

Laboratory in Automobile Making. Thomas J. Fay. Considers some of the requirements in a laboratory, the testing necessary, and the general utility of such a laboratory. Ills. 3000 w. Automobile—Sept. 16, 1909. No. 7795.

Lighting.

"Rushmore" Headlamps and Generators. Illustrates and describes features of these lamps and generators. 2500 w. Auto Jour—Sept. 4, 1909. No. 7725 A.

Tests of Headlights for Motor Car and Motor Cycles. A report of tests and conclusions under the open competition rules of the Royal Automobile Club. 2500 w. Autocar—Aug. 21, 1909. No. 7426 A.

See also Acetylene Generators, under AUTOMOBILES.

Lubrication.

Some Facts About Mechanical Lubricators—Troubles and Cures. An illustrated discussion of functional and organic troubles. 1500 w. Auto Jour—Aug. 28, 1909. No. 7638 A.

Moline.

Moline Model "M" 1910. Information concerning these high-grade cars, selling at $1500. 1700 w. Automobile—Sept. 23, 1909. No. 8040.

Mora.

One 1910 Mora "Light Four." Illustrated description of a four-cylinder chassis to be constructed by this Newark firm. 2000 w. Automobile—Sept. 9, 1909. No. 7705.

Motor Rating.

The Horse-power of Petrol Engines. C. F. Dendy Marshall. Explains the steps leading to the rating formula $\frac{D^2SN}{12}$. 1200 w. Autocar—Sept. 18, 1909. No. 8106 A.

Motor Tests.

Test of Pierce Water-Cooled Motor. J. A. Luhrman and G. W. Woodward. Paper read at Chicago meeting of Soc. of Auto. Engrs. Detailed description of the methods of testing, with tables of results. 5500 w. Automobile—Sept. 23, 1909. No. 8038.

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Napier.

A 6-Cylinder Car for the Colonies. Illustrates and describes the leading features of the 30 h. p. Napier. 1000 w. Auto Jour—Aug. 21, 1909. No. 7427 A.

Omnibuses.

The Advantages and Disadvantages of Motor Omnibuses. Results of Working. K. Otto. 3300 w. Bul Int Ry Cong—July, 1909. No. 8024 G.

The Advantages & Disadvantages of Motor Omnibuses. Results of Working. Mr. Mauclère. 13500 w. Bul Int Ry Cong—July, 1909. No. 8023 G.

Motor Omnibuses in London (Die Stellung der Motoromnibusse im öffentlichen Verkehr Londons). Herbert Bauer. A review of their development, traffic handled, etc. Ills. 2500 w. Zeitschr d Mitt Motorwagen Ver—Aug. 31, 1909. No. 7980 D.

Pierce-Arrow.

Pierce-Arrow for 1910. Illustrates and describes improvements, introduced in new models. 2200 w. Automobile—Sept. 2, 1909. No. 7554.

Repairs.

Helpful in Overhauling the Car. Stillman Taylor. Suggestions for cleaning and inspection, and reassembling. 3500 w. Automobile—Sept. 2, 1909. No. 7553.

Stearns.

Concerning the Stearns 15-30. Illustrates and describes details of the "New Series" 15-30. 1500 w. Automobile—Sept. 23, 1909. No. 8039.

Vauxhall.

A Car Which Has Made a Remarkable Name. Illustrates and describes the leading features of the 20-h. p. Vauxhall. 2200 w. Auto Jour—Aug. 28, 1909. No. 7637 A.

Wheels.

Meritorious Features of Wire Wheels. Joseph A. Mackle. An illustrated description of tests made in England on improved wire wheels. 1800 w. Automobile—Sept. 9, 1900. No. 7704.

Automobile Wheels, Rims and Tires. Thomas J. Fay. Detailed discussion, with illustrations, of the design, and important particulars. 3500 w. Automobile—Sept. 2, 1909. Serial. 1st part. No. 7552.

COMBUSTION MOTORS.

Alcohol Storage.

4,000 Cubic Metre Alcohol Storage Tank at Delsberg, Switzerland (Spiritusbehälter von 4,000 m³ Inhalt der Eidg. Alkoholverwaltung Depot Delsberg). Illustrated description. 1500 w. Schweiz Bau—Aug. 21, 1909. No. 7971 B.

Compression.

Varying the Volume of the Compression Chamber in Internal-Combustion Engines. Illustrates and describes a device invented by E. G. E. Beaumont. 1500 w. Prac Engr—Sept. 10, 1909. No. 7850 A.

Gas-Engine Design.

Offsetting Cylinders in Single Acting Engines. Discussion of the paper of Prof. Thurston M. Phetteplace. 1500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8101 F.

Gas-Engine Efficiency.

A Method of Improving the Efficiency of Gas Engines. Thomas E. Butterfield's paper is discussed. 1000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8100 F.

Gas-Engine Lubrication.

See Engine Lubrication, under STEAM ENGINEERING.

Gas Engines.

The Work of the British Association Committee on Gaseous Explosions. Dugald Clerk. Read before the Engng. Sec. of the British Assn. at Winnipeg. On the practical application of knowledge acquired by investigation of the properties of gaseous explosions in internal-combustion motors. 3000 w. Engng—Sept. 3, 1909. No. 7755 A.

Gaseous Explosions. Second report of the Committee presented to the British Assn. at Winnipeg. Ills. 11500 w. Engng—Sept. 3, 1909. No. 7754 A.

On Heat-Flow and Temperature—Distribution in the Gas-Engine. Bertram Hopkinson. An experimental investigation into the temperatures reached by the hotter parts of a gas-engine of considerable size, the conditions which determine them, and the circumstances in which preignition may be caused by hot metal. Also abstract of discussion. 26000 w. Inst of Civ Engrs—No. 3799. No. 8165 N.

Large Gas Engines. P. R. Allen. Abstract of a lecture at the Imp. Int. Ex., Shepherd's Bush. Brief historical review, describing details of construction, and comparing steam and internal combustion engines. 2000 w. Elect'n, Lond—Sept. 17, 1909. No. 8113 A.

The Strength of Gas Engine Crank Shafts. Michael Longridge. Abstracted from the annual report for 1908 of the Chief Engr. to the British Engine, Boiler, and Elec. Ins. Co., Ltd. Mathematical. 2000 w. Mech Engr—Sept. 10, 1909. No. 7852 A.

Gas Engines for Mining Purposes. A. S. Atkinson. Brief account of the success attained in the use of gas engine power plants for mines. 1600 w. Min & Sci Pr—Aug. 28, 1909. No. 7513.

Gas Power Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

Report of Gas Producer Development Abroad. Discussion at the Washington meeting. 1500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8098 F.

The Construction of Gas Producers.

Dr. Oskar Nagel. Illustrated detailed descriptions of types. 3000 w. Elec-Chem & Met Ind—Sept., 1909. No. 7594 C.

Oil Engines.

See Pumping, under HYDRAULIC MACHINERY.

HEATING AND COOLING.

Fans.

Capell's Centrifugal Fan. Illustrates and describes recent improvements made in this fan. 1000 w. Mech Engr—Sept. 17, 1909. No. 8118 A.

Electrically-Driven Fans. George W. Baird. Gives tabulated report of tests and general information. 1500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8090 H.

Hot-Air Heating.

A Defense of the Warm Air Furnace. Charles S. Prizer. Abstract of presidential address at meeting of the Federal Furnace League. Answers the usual objections made to this system. 2000 w. Heat & Vent Mag—Sept., 1909. No. 7883.

Hot-Water Heating.

Design of a Central Heating System with Forced Circulation of Hot Water. Joseph T. Maguire. Discusses the design of a forced-circulation, central, hot-water heating system. 3000 w. Eng News—Sept. 2, 1909. No. 7537.

See also Piping, under HEATING AND COOLING.

Liquid Air.

The Liquifaction of Gases and Commercial Production of Oxygen. Cecil Lightfoot. Illustrates and describes machines for the production of the lowest temperatures for the liquifaction of gases and the chemical separation of gaseous mixtures. 2000 w. Elec Jour—Sept., 1909. No. 7571.

Ozone Ventilation.

See Ventilation, under HEATING AND COOLING.

Piping.

Sizes of Pipe Mains for Hot Water Heating. Charles L. Hubbard. Gives curves for determining sizes, explaining their use. 700 w. Mach, N Y—Sept., 1909. No. 7504 C.

Radiators.

Indirect Radiators. Presents the advantages of this method of heating. Ills. 1000 w. Dom Engng—Sept. 11, 1909. No. 7709.

Refrigeration.

The Molecular Kinetics of Solids, Liquids and Vapors. Dr. J. E. Siebel. A study of the thermo-dynamics of vapors from the kinetics of solids and liquids. 3000 w. Ice & Refrig—Sept., 1909. No. 7582 C.

A Test of the Improved Reynolds Dense-Air Ice Machine, with Observations on Refrigeration on Board Naval Vessels. William Strother Smith. Describes the machine and reports test. Ills. 1500 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8093 H.

Ventilation.

Heating, Cooling and Humidifying. Sterling H. Bunnell. On methods of producing any desired conditions either automatically controlled or under the management of an engineer. 2500 w. Ind Engng—Sept. 15, 1909. No. 8031 C.

Use of Ozone Generators in the Ventilation of Buildings. Illustrated account of the installation in the Chicago public library. 1000 w. Heat & Vent Mag—Sept., 1909. No. 7881.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Centrifugal Pumps for Docking and Other Purposes. Illustrates and describes recent types of centrifugal pumps installed in shipbuilding plants. 2500 w. Prac Engr—Sept. 3, 1909. No. 7736 A.

Experiments with Centrifugal Pumps. J. G. Davis and W. R. Harding. Derives a general formula and describes trials made. Ills. 4500 w. Engr, Lond—Aug. 27, 1909. No. 7659 A.

Electric Pumps.

See Pumping, under MINING.

Pelton Wheels.

Running Losses in Pelton Wheels Under Variable Peripheral Speed (Arbeitsverlust bei der Peltonradschaufel infolge der variablen Umfangsgeschwindigkeit). H. Egli. Mathematical. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 30, 1909. No. 7978 D.

Pumping.

Pumping by Oil-Engines: Divi Irrigation Works. Percy Hawkins. Describes a scheme for irrigating this island in the Bay of Bengal, at the mouth of the Kistna River. 3000 w. Inst of Civ Engrs—No. 3771. No. 8166 N.

Pumps.

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Prof. R. C. Carpenter. Description of pumps and pumping system with results of tests. Ills. 6000 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8096 F.

Turbine Measurements.

Measurements on Turbine Conduits (Ueber Messungen an Turbinenkanälen). Hans Jaeger. An elaborate discussion of methods of hydraulic measurement in turbine plants. Ills. Serial. 1st part. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 10, 1909. No. 7976 D.

Turbine Plants.

The Operation of Water-Power Plants in Winter (Der Betrieb einer Wasserkraftanlage im Winter). W. v. Winkler. Discusses the methods of coping with the ice problem. Ills. 6000 w. Elektrotech u Maschinenbau—Aug. 15, 1909. No. 7993 D.

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MACHINE ELEMENTS AND DESIGN.

Crank Shafts.

See Gas Engines, under COMBUSTION MOTORS.

Cylinders.

Investigation of the Stresses in Thick-Walled Hollow Cylinders Under Internal Pressure (Untersuchungen über die Anstrengung dickwandiger Hohlzylinder unter Innendruck). W. Krüger. Describes tests and their theory, and gives results. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 28, 1909. No. 8156 D.

Eccentric Loading.

The Determination of the Pressures on the Supports of Structures Loaded Eccentrically. H. F. Harris. Considers the conditions of possible loading under three general classes. 1000 w. Prac Engr—Sept. 3, 1909. No. 7735 A.

Gears.

Factors for Proportioning Spur Gears. Charles H. Logue. Gives formulæ and constants for proportioning solid and split spur gears and for estimating weights. 2500 w. Am Mach—Vol. 32. No. 39. No. 8202.

Experimental Spur-Wheel Reduction-Gear for High-Speed Steam-Turbines. Illustrated description of a reducing gear to be applied to marine turbines, constructed for George Westinghouse from the designs of Rear-Admiral George W. Melville and John H. Macalpine. 5000 w. Engng—Sept. 17, 1909. No. 8123 A.

Gyrostats.

Principles and Applications of the Gyrostat. Horace B. McCabe. Describes the mechanism and actions of gyrostats, giving general rules governing their action. Ills. 2200 w. Am Mach—Vol. 32. No. 37. No. 7769.

A Study of Gyroscopic Phenomena (Etude sur le Phénomène gyroscopique). M. Astier. Mathematical. Ills. 4500 w. Rev de Mécan—Aug., 1909. No. 7926 E + F.

Impact.

The Impact of Elastic Solid Bodies. A study of the physical and mechanical principles involved in the theory of impact of elastic solids. 4000 w. Locomotive—July, 1909. No. 7508.

Riveted Joints.

The Strength of Riveted Joints. Describes the tests made by M. C. Tremont. 3000 w. Builder—Sept. 18, 1909. No. 8103 A.

Torsion.

The Behavior of Ductile Material Under Torsional Strain. C. E. Larard. Read before the Engineering Section of the British Association at Winnipeg. A report of research experiments. Ills. 4500 w. Engng—Sept. 3, 1909. Serial. 1st part. No. 7750 A.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Elements of Assembling Operations. Alfred Spangenberg. Considers methods of assembling that will ensure accuracy, economy, and standardization. Ills. 4000 w. Mach, N Y—Sept., 1909. No. 7501 C.

Blacksmith Shops.

Notes on Smithwork. The present number deals with bending iron. Ills. 1600 w. Mech Wld—Sept. 3, 1909. Serial. 1st part. No. 7745 A.

Brass Founding.

Notes on the Care of Crucible Furnaces and Character of Fire Brick to Be Used in Them. Considers the quality of the fire-brick, and the necessary requirements when used in lining crucible furnaces. Ills. 1800 w. Brass Wld—Sept., 1909. No. 7877.

Button Making.

Dies for Covering Buttons. Charles Weslow. Illustrates and describes dies and tools for manufacturing cloth buttons. 1500 w. Mach, N Y—Sept., 1909. No. 7503 C.

Can Making.

The Manufacture of Tin Cans. H. M. Lane. Illustrates and describes the machinery and processes developed by the Sherwin-Williams Co., Cleveland, O. 2000 w. Ir Age—Sept. 2, 1909. No. 7514.

Making Solderless Cans for Food Products. Ralph E. Flanders. Illustrates and describes methods and machinery employed at the Max Ams Machine Co.'s works. 2000 w. Mach, N Y—Sept., 1909. No. 7500 C.

Converters.

Small Converter Practice (Das Kleinbessemerei-Verfahren). Herr Hutmacher. Discusses the use of the bessemer converter in the steel foundry. Ills. 1300 w. Giesserei-Zeit—Aug. 15, 1909. No. 7960 D.

Cupolas.

Melting Iron in a Foundry Cupola. Prof. H. McCormack. A report of experimental investigations on heat developed. 2500 w. Elec-Chem & Met Ind—Sept., 1909. No. 7593 C.

Construction, Smelting Process and Charging of Cupolas (Bau der Kupolöfen, Schmelzvorgang und Begichtung). A. Messerschmitt. A discussion of all branches of cupola practice. Ills. Serial. 1st part. 5600 w. Stahl u Eisen—Aug. 4, 1909. No. 7950 D.

Enamelling.

The Production of Welded, Enameled Vessels (Die Herstellung geschweisster emaillierter Behälter). Karl Rietkötter. Describes the plant and process. Ills. 1500 w. Stahl u Eisen—Aug. 18, 1909. No. 7954 D.

Engraving Machines.

Engraving Dies by Automatic Machinery. Snowden B. Redfield. Illustrated

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description of these mechanical engraving devices, and the preparations for the work. 3500 w. Am Mach—Vol. 32. No. 38. No. 8015.

Etching.

The "Painting-On" Method of Etching Brass Signs and Similar Articles. Illustrated detailed description of the process. 2500 w. Brass Wld—Sept., 1909. No. 7878.

Files.

Vernaz Milling Files Report of the Committee on Science and Arts, of the Franklin Institute, on the milling files invented by Alexis Vernaz of Yverdon, Switzerland. Ills. 1200 w. Jour Fr Inst—Sept., 1909. No. 7886 D.

Foundry Equipment.

The Modern Foundry Plant (Die Anlage moderner Metallgiessereien). Discusses briefly modern foundry equipment and practice. Ills. Serial. 2 parts. 3500 w. Giesserei-Zeit—Aug. 1, 1909. No. 7959, each D.

Foundry Practice.

Waste Heat in Foundries. Walter J. May. Shows the waste heat from cupola and crucible furnaces, suggesting ways of utilizing it. 1500 w. Prac Engr—Sept. 17, 1909. No. 8115 A.

Furnaces.

Furnaces to Anneal, Harden and Color. E. F. Lake. Illustrates and describes automatic apparatus and furnaces to anneal and harden metals with gas. 2000 w. Am Mach—Vol. 32. No. 36. No. 7703.

The Vaughan-Hughes Heat-Treatment Process Furnaces. Illustrates and describes furnaces for case-hardening, annealing, tempering, etc. 2000 w. Ir & Coal Trd Rev—Sept. 3, 1909. No. 7762 A.

Grinding Machines.

Notes on the Design of a Grinding Machine. Diagrams and details of the work are given. 2000 w. Am Mach—Vol. 32. No. 35. No. 7524.

The Bath Duplex Internal Grinding Machine. Illustrated detailed description of the latest machine for this work. 2500 w. Ir Age—Sept. 30, 1909. No. 8198.

Lathes.

A Large Turbine Lathe. Illustrations and brief description of a large turbine lathe built at Leeds, for marine engine works at Genoa. 500 w. Engr, Lond—Sept. 3, 1909. No. 7759 A.

Machine Tools.

Chapters in the Early History of Machine Tools. Joseph Horner. The present article outlines the history of the lathe. Ills. 3000 w. Mach, N Y—Sept., 1909. Serial. 1st part. No. 7497 C.

The Modern Machine Tool. Editorial review of the remarkable advance made in this field. 2500 w. R R Age Gaz—Sept. 3, 1909. No. 7583.

Special Machines for Making Comptometers. Illustrates and describes force and punch presses, spring making machine, lathe gage, riveting hammer, etc. 1500 w. Am Mach—Vol. 32. No. 37. No. 7770 .

Six Alsatian Machine Tools of Recent Design. Illustrated descriptions of motor-driven machines exhibited at Nancy, France. 2000 w. Am Mach—Vol. 32. No. 39. No. 8201.

Boulton and the Soho Works. Illustrated descriptions of old tools for boring, lathes, hammers, Murdoch's gas plant, planing machine, etc. 1000 w. Engr, Lond—Sept. 10, 1909. No. 7867 A.

Milling Machines.

A High-Speed Vertical Milling Machine. Illustrated detailed description of a machine built in Birmingham, Eng. 1000 w. Engr, Lond—Sept. 17, 1909. No. 8135 A.

Molding Machines.

Recent Hydraulically Operated Molding Machines (Neuere Formmaschinen mit Druckwasserbetrieb). A. Lohse. Illustrates and describes a large number of machines for a variety of work. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 21, 1909. No. 8154 D.

Recent Molding Machines (Neuere Formmaschinen). F. Hermann. Describes a number of machines for various purposes. Ills. Serial. 2 parts. 3000 w. Giesserei-Zeit—Aug. 1 and 15, 1909. No. 7958, each D.

Oil Removal.

Removing Oil from Machined Pieces. Fordyce W. Brown. Illustrated description of apparatus for removing oil from small screws, studs, etc., used in the manufacture of watches. 1400 w. Ir Age—Sept. 23, 1909. No. 8001.

Pattern Making.

Pipe Patterns for Single Castings. W. Peters. Suggestions for pipe-pattern work, with illustrations. 1200 w. Am Mach—Vol. 32. No. 35. No. 7523.

Pipe-Threading Machines.

Modern Machines for Pipe Threading. J. F. Springer. Illustrates and describes large pipe threading machines, and some examples of hand threading. 3500 w. Power—Sept. 7, 1909. No. 7599.

Pneumatic Tools.

See Riveting Machines, under MACHINE WORKS AND FOUNDRIES.

Press Tools.

Sectional Die for the Subpress. A. M. Cahill. Illustrated description. 1200 w. Am Mach—Vol. 32. No. 35. No. 7522.

Simple and Automatic Stop-Pins for Press Work. H. A. S. Howarth. Illustrates and describes types, noting their uses, and their merits and faults. 2000 w. Mach, N Y—Sept., 1909. No. 7505 C.

Riveting Machines.

Pneumatic Jam Riveters. W. T. Sears. Illustrates and describes forms of modified toggles, and calls attention to points

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regarding riveting by air. 2000 w. Am Mach—Vol. 32. No. 36. No. 7699.

Rope Making.

The Machines That Make Cordage. Illustrates and describes some mechanical combers and "twisters" now replacing old methods of rope making. 3500 w. Am Mach—Vol. 32. No. 35. No. 7521.

Shop Appliances.

Self-Contained Backing-Off Attachment. W. J. Kaup. Illustrated description of a new design to be used for formed cutters. 700 w. Am Mach—Vol. 32. No. 36. No. 7701.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. The second article of a series, giving a study of the problems of factory construction. 6000 w. Engineering Magazine—Oct., 1909. No. 8175 B.

Shop Practice.

Making "Under Reamers" for Oil Well Casing. Carroll Ashley. Illustrated description. 1400 w. Am Mach—Vol. 32. No. 36. No. 7702.

Obtaining Accurate Records of Wheel Fits. Illustrates and describes a new American hydraulagraph, an instrument which gives the exact pressure used in making force fits. 1200 w. Am Mach—Vol. 32. No. 35. No. 7520.

The Modern Spirit in the Machine Shop (Der moderne Geist in der Maschinenfabrik). Alexander Rothert. A review of modern tendencies in production engineering. Serial. 1st part. 4000 w. Tech u Wirt—Aug., 1909. No. 8152 D.

Shops.

Extended Plant of the American La France Fire Engine Company. Plan and illustrated description of the rearranged and extended manufacturing plant. 2500 w. Eng Rec—Sept. 25, 1909. No. 8070.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Transportation.

The Shop Transportation Problem. Oscar E. Perrigo. Describes different types of handling devices installed in manufacturing plants. 3000 w. Ind Engng—Sept. 15, 1909. No. 8049 C.

Tool Making.

Observations on the Making of High-Speed Steel Tools. O. M. Becker. Considers the importance of keeping data, and the kind of data to be kept, as a guide to the production of superior tool steel. 3000 w. Mach, N Y—Sept., 1909. No. 7498 C.

Welding.

The Development of Oxy-Acetylene Welding. Henry Cave. Read before the Int. Acet. Assn. Describes the recent development and some of the work accomplished. Ills. 1200 w. Am Mach—Vol. 32. No. 38. No. 8013.

Welding Pipe Work for Superheated Steam. William F. Fischer. Explains the advantages and efficiency of the weld, and describes the processes employed. Ills. 5000 w. Power—Sept. 28, 1909. No. 8143.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Steels. Leon Guillet. Reviews recent developments in their manufacture. Read at Copenhagen meeting of Int. Soc. for Test. Mat. 2500 w. Ir Age—Sept. 23, 1909. No. 8002.

Cast Iron.

Effect of Structure of Cast Iron Upon Its Physical Properties. F. J. Cook and G. Hailstone. Gives microscopic evidence of the reason why irons of similar chemical composition have different relative strengths. Ills. 1800 w. Foundry—Sept., 1909. No. 7606.

The Testing of Cast Iron (Beitrag zur Prüfung des Gusseisens). C. Jüngst. Discusses test bars and gives comparative test results on bars of various shapes and sizes. Ills. 3000 w. Stahl u Eisen—Aug. 4, 1909. No. 7949 D.

Galvanized Metals.

The Testing of Galvanized and Other Zinc-Coated Metals. William H. Walker. Condensed from a paper before the Am. Soc. for Test Mat. Describes tests made, stating their value. 2500 w. Eng News—Sept. 2, 1909. No. 7540.

Metallography.

Inaugural Address on the Crystallization of Iron and Steel. A. McArthur Johnston. Deals mainly with the size of the crystals in iron and steel and the effect on these of heat treatment, mechanical treatment, and of the strains and stresses set up during work. A microscopic study. Supplement of Ills. 8000 w. Jour Chem, Met, & Min Soc of S Africa—July, 1909. No. 7843 E.

Microscopy and Macroscopy in the Workshop and Foundry. Abstract of a lecture by J. E. Stead, at Copenhagen, giving examples of cases where both macroscopy and microscopy had been found of service in testing steel. 2000 w. Ir & Coal Trds Rev—Sept. 17, 1909. Serial. 1st part. No. 8136 A.

Steel.

Grinding Sparks of Steel. Max Bermann. Read at Copenhagen meeting of the Int. Soc. for Test. Mat. Explains how they may become a basis of classification. Ills. 3000 w. Ir Age—Sept. 23, 1909. No. 8003.

Tool Steels.

Range of Utility of High Speed Steel. O. M. Becker. Considers applications to meet special and peculiar conditions, cost, improvement in performance, etc. 3500 w. Ir Trd Rev—Sept. 9, 1909. Serial. 1st part. No. 7678.

MEASUREMENT.

Calorimetry.

Calorimetry, and the Determination of the Calorific Value of Philippine and Other Coals from the Results of Proximate Analysis. Alvin J. Cox. Discusses methods of determination, giving tables, charts, and results. 6500 w. Philippine Jour of Sci—May, 1909. No. 7789 N.

Gas Velocity.

Determination of the Velocity of Gas with the Pitot Tube. O. E. Jager and George C. Westly. Describes the method of determining the velocity of gas in a flue by means of a Pitot tube. 1200 w. Eng & Min Jour—Sept. 4, 1909. No. 7568.

Gauges.

The Manufacture of Gages. Discusses the principles of development of a gaging system and the making of plug, and ring gages. Ills. 3500 w. Mach, N Y—Sept., 1909. No. 7502 C.

Hydraulagraph.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Impact Tests.

The Influence of Time and Temperature on Impact Tests (Influence du Temps et de la Température sur les Essais au Choc). André Le Chatelier. A review of the author's published results of twenty years of experimentation. 1500 w. Rev de Métal—Aug., 1909. No. 7920 E + F.

Recent Impact Tests on Cold Specimens of Ordinary and Special Steels (Nouveaux Essais de Choc à Chaud sur les Aciers ordinaires et les Aciers spéciaux). L. Guillet and L. Revillon. Gives results indicating the influence of time and temperature. Ills. 2500 w. Rev de Métal—Aug., 1909. No. 7921 E + F.

Laboratories.

Manufacturing Laboratory at Neubabelsberg. Henry Hess. Illustrated detailed description of laboratories for experimental work for plants devoted to the manufacture of fire-arms, cartridges, powder, etc. 1200 w. Am Mach—Vol. 32. No. 36. No. 7698.

The Metal Section of the Testing Laboratory of the Conservatoire National des Arts et Métiers (La Section des Métaux du Laboratoire d'Essais du Conservatoire national des Arts et Métiers). Pierre Breuil. Describes the experimental equipment and outlines the results of the more important researches of recent years. Ills. 23000 w. Mem Soc Ing de France—July, 1909. No. 7904 G.

Lubricant Testing.

Oil-Friction Testing Machine. William Alexander. Illustrated description of a machine designed and made in the Wellington Technical School, New Zealand. 1000 w. Engr, Lond—Sept. 17, 1909. No. 8132 A.

Planimeters.

Principle of Planimeter Operation. M. R. Wells. Explanation of the construction and operation. Ills. 1500 w. Power—Sept. 7, 1909. No. 7600.

Pyrometry.

The Electrical Pyrometer. Francis H. Davies. Reviews briefly the early methods of temperature measurement, comparing with the accuracy now possible. Describes the three classes of electrical pyrometers. 2000 w. Elec Engr, Lond—Sept. 17, 1909. No. 8108 A.

Testing Methods.

See Cast Iron, and Steel, under MATERIALS OF CONSTRUCTION; and Laboratories, under MEASUREMENT.

Water.

Methods of Measuring the Flow of Water. Franklin Van Winkle. Considers tank measurement, tank-orifice method, direct measurement by orifice, and flow through valve. 4000 w. Power—Sept. 7, 1909. No. 7605.

POWER AND TRANSMISSION.

Air Compressors.

The Design of Air Compressors. Arthur J. Colville. Discusses the determining of the actual capacity of the machine, and the equal distribution of the power between the cylinders in a two stage machine. 1200 w. Prac Engr—Sept. 10, 1909. Serial. 1st part. No. 7851 A.

Indicating a Compressor Discharge Pipe. Snowden B. Redfield. Gives some peculiar wave motion diagrams and explains how they can be used to determine the economic performance of an air or gas compressor. 2500 w. Am Mach—Vol. 32. No. 37. No. 7771.

Costs.

Costs of a Gas Engine and of a Combined Steam Plant. T. M. Chance. Considers the cost of operating and maintaining, under like conditions, a 1000-kw plant of each type, comparing the economy. 3000 w. Eng Rec—Sept. 4, 1909. No. 7550.

Electric Driving.

Increasing the Efficiency of the Electric-Motor Drive. Howard S. Knowlton. A review of a large series of tests of electric driving. 3000 w. Engineering Magazine—Oct., 1909. No. 8172 B.

The Advantage of Group or Individual Drive in Certain Installations. C. A. Graves. Aims to show why group or individual drive is preferable, giving examples. 3800 w. Elec Age—Sept., 1909. No. 7841.

Electric Control for Rolling-Mill Motors. C. T. Henderson. An illustrated review of the development of controlling apparatus for applications of electricity in the steel industry. 2500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8178 F.

We supply copies of these articles. See page 323.

Power Used in the Re-manufacture of Lumber, with Special Reference to Central-Station Energy for That Purpose. C. H. Sicott. Abstract of a paper before the Mich. Elec. Assn. Considers the methods and requirements of power for woodworking tools, and the importance of recording essential data. 3000 w. Elec Rev, N Y—Sept. 4, 1909. Serial. 1st part. No. 7589.

Gas Compressors.

Test of Gas Compressor No. 3 of the New Orleans Gas Light Company, Saturday, January 9, 1909. W. B. Gregory. Illustration with report of test and results. 3000 w. Jour Assn of Engng Socs—July, 1909. No. 7810 C.

Mechanical Plants.

The Electrical and Mechanical Installation in the Hotel La Salle. Howard Ehrlich. Illustrated description of the very complete equipment of Chicago's newest and largest hotel. 3000 w. Elec Rev, N Y—Sept. 4, 1909. No. 7590.

Electricity in the Arden Residence of the Late E. H. Harriman. Brief illustrated description of electrical service for lighting, heating, cooking, motor applications, telephone systems and call-bells. 2500 w. Elec Rev, N Y—Sept. 18, 1909. No. 7837.

Power Plants.

Power Generation in School Buildings. Charles L. Hubbard. Illustrates and describes the power plant of the Newton Technical High School building, Newton, Mass. 3000 w. Ind Engng—Sept. 15, 1909. No. 8047 C.

Shaft Bearings.

Line Shaft Bearings. Hugo Presser. Shows the importance of uniformity in their supports. Ills. 2500 w. Ind Engng—Sept. 15, 1909. No. 8050 C.

STEAM ENGINEERING.

Air Pumps.

Notes on the Design of Vertical Air Pumps. Michael Longridge. Calls attention to a point usually overlooked in the design of vertical single-acting air pumps, and suggests an improved design. Ills. 1200 w. Mech Engr—Sept. 3, 1909. No. 7744 A.

An Improved Form of Air Pump. Describes a form of air pump in which the condensed water and air from the condenser enter the pump by separate inlets. Ills. 1800 w. Prac Engr—Aug. 27, 1909. No. 7643 A.

Boiler Cleaning.

Heat and Water Conserving Systems for Cleaning and Washing Out Boilers. J. E. Epler. Considers the methods in common use for saving the heat in the boilers. 1800 w. Am Engr & R R Jour—Sept., 1909. No. 7575 C.

Boiler Design.

Heat Transfer and Future Boiler Practice. Arthur H. Allen. Suggests a new type of boiler on the principle of rapid heat-transference. 4000 w. Power—Sept. 21, 1909. No. 7875.

Graphical Determination of Boiler Bracing. S. F. Jeter. Charts and explanatory notes. Also a description of how the diagrams are made. 2000 w. Power—Sept. 14, 1909. No. 7722.

Boiler Explosions.

Boiler Explosion in an Electric Light Plant. An illustrated account of the explosion on June 15, 1909, in Denver, Colo. 4500 w. Locomotive—July, 1909. No. 7506.

The Hull Heating Boiler Explosion. A report of the investigation to determine the cause of the explosion of the high-pressure hot-water boiler in a school building. 3000 w. Mech Engr—Aug. 20, 1909. No. 7431 A.

Explosions of Two Boilers at Eygelshoven, September 15, 1908 (Intploffing van twee Stoomketels te Eygelshoven op 15 September 1908). Report of an investigation of the causes and results. Ills. Serial. 1st part. 7000 w. Ingenieur—Aug. 21, 1909. No. 8158 D.

Summary of Boiler Explosions in France During 1907 (Bulletin des Accidents d'Appareils à Vapeur survenus pendant l'Année 1907). Gives the character, circumstances, consequences and supposed causes. 4400 w. Ann d Ponts et Chaussées—1909-IV. No. 7912 E + F.

Boiler Firing.

Firing Cheap Grades of Coal Economically. William Kavanagh. Discusses the three methods usually employed in banking, the systems of firing, etc. 1000 w. Elec Wld—Sept. 2, 1909. No. 7530.

Boiler Furnaces.

Grate Areas for Water-Tube Boilers. T. F. J. Maguire. Considers the relation between the grate area and the kind of fuel used for various types. 3000 w. Engineering Magazine—Oct., 1909. No. 8176 B.

Boiler Management.

The Dilution of Flue Gases. Wilfred Yorke. A study of the effect of diluting the flue gases with undue admission of air. 1000 w. Power—Sept. 14, 1909. No. 7719.

Condensers.

Bimetallic Condenser Tubes. Edward K. Davis. Shows the durability of such tubes and considers the comparative effects of the copper-aluminium combination upon the design and efficiency of a condenser. 1800 w. Eng News—Sept. 2, 1909. No. 7536.

English Practice in Condensing Equipment. James A. Seager. A general survey of British practice and methods of design with particular reference to surface condensers. Ills. 3500 w. Power—Sept. 14, 1909. No. 7718.

We supply copies of these articles. See page 323.

Notes on Condensing and Water Cooling Plants. F. Lunn. Read before the Incor. Munic. Elec. Assn. Considers types of condensers and cooling plants. 4500 w. Elec Engr, Lond—Sept. 3, 1909. No. 7726 A.

Tinsley's Patent Condenser. Illustrated description. 1200 w. Col Guard—Sept. 3, 1909. No. 7746 A.

A Remarkable Condenser Performance. A report of results obtained with Wheeler surface condenser in the Williamsburg power station, Brooklyn, N. Y. 2000 w. Power—Sept. 28, 1909. No. 8144.

A Remarkable Condenser Performance. Reports success attained with a Wheeler "dry tube" condenser installed in the Williamsburg power station, Brooklyn, N. Y. Ills. 2000 w. Ind Engng—Sept. 15, 1909. No. 8048 C.

See also Air Pumps, under STEAM ENGINEERING.

Cooling Towers.

See Condensers, under STEAM ENGINEERING.

Engine Erection.

Erecting an Engine. F. Wiegand. Considers the different operations of building. Ills. 1600 w. Power—Sept. 14, 1909. No. 7720.

Erecting an Engine. F. Wiegand. Detailed directions for the work. 2000 w. Power—Sept. 21, 1909. No. 7873.

Erecting an Engine. F. Wiegand. The present article deals with the piston and reciprocating parts. 3000 w. Power—Sept. 28, 1909. No. 8145.

Engine Failures.

Steam Engine Breakdowns and Their Lessons. Michael Longridge. Abstract from report for 1908 of the Chief Engineer to the British Engine, Boiler, and Electrical Insurance Co., Ltd. Ills. 4000 w. Mech Engr—Sept. 3, 1909. No. 7743 A.

Engine Lubrication.

Lubricators and Lubrication. W. H. Wakeman. Discusses these features of steam and gas engine work, describing types of lubricators. Ills. 2500 w. Power—Sept. 7, 1909. Serial. 1st part. No. 7603.

Automatic Engine Lubrication with Gravity Feed. Romyn Hitchcock. Illustrated description of the Mille apparatus. 2000 w. Power—Sept. 7, 1909. No. 7601.

Fuel Contracts.

See same title, under MARINE AND NAVAL ENGINEERING.

Fuels.

A Comparison of the Heating Powers of Fuels. A. L. Hodges. Brief consideration of natural and artificial fuels. 2000 w. Min Wld—Sept. 25, 1909. No. 8084.

Characteristics of Bituminous Coals and Low Grade Fuels. C. M. Ripley. Examines figures presented by W. E. Crane. 1800 w. Power—Sept. 7, 1909. No. 7604.

Fuel Specifications.

The Purchase of Coal by the City of New York. Extracts from a report by Otto H. Klein, concerning present practice and proposed specifications based on heat units contained. 1700 w. Eng News—Sept. 9, 1909. No. 7627.

Fuel Testing.

See Calorimetry, under MEASUREMENT.

Heat.

Heat: Its Use and Distribution. Lyman C. Reed. Briefly explains the phenomena of heat transference, considers some of its properties and uses, and outlines the relation of various heat storage elements and their use. 6000 w. Jour Assn of Engng Socs—Aug., 1909. No. 8057 C.

Steam Headers.

Diameter of Steam Headers. Franz J. Denk. Gives a table for different horsepowers, pressures and velocities, with explanation. 900 w. Power—Sept. 7, 1909. No. 7602.

Steam Pipes.

Materials for Pipe Lines. William D. Ennis. Discusses the most suitable material for piping, fittings, and valves used in power house installations. Ills. 2000 w. Power—Sept. 21, 1909. No. 7872.

The Design of Pipes. T. E. Thain. Discusess the primary considerations and methods of determining dimensions, dealing especially with steam pipes. 1200 w. Prac Engr—Aug. 20, 1909. Serial. 1st part. No. 7428 A.

See also Welding, under MACHINE WORKS AND FOUNDRIES.

Turbine Balancing.

The Mass Balancing of Steam Turbine Rotors. W. H. Heaton. Describes practical methods of balancing in the shop. 1500 w. Cassier's Mag—Sept., 1909. No. 7780 B.

Turbine Governing.

Determining the Capacity of an Oil-Pressure Turbine Governor (Ueber die Wahl des Arbeitsvermögens eines Turbinen-Oeldruck-Reglers). A Pfau. Mathematical discussion of the determination of the size of the regulating cylinder. Ills. 3000 w. Die Turbine—Aug. 5, 1909. No. 7973 D.

Turbines.

The Design and Performance of the A. E. G. Steam Turbine Plants. Illustrated description. 2000 w. Elec Rev, Lond—Sept. 3, 1909. No. 7728 A.

Test of Terry Steam Turbine. C. W. Dyson. Illustrated description with report of tests. 1200 w. Jour Am Soc of Nav Engrs—Aug., 1909. No. 8092 H.

Small Steam Turbines. Discussion of George A. Orrok's paper. 9500 w. Jour Am Soc of Mech Engrs—Sept., 1909. No. 8097 F.

We supply copies of these articles. See page 323.

The Steam Turbine in English Power Houses. James A. Seager. Gives reasons for its popularity in electrical work. Ills. 3000 w. Power—Sept. 7, 1909. No. 7597.

The Large Steam Turbine in the Electrical Industry (Die Beziehungen der Gross-Dampfturbine zur Elektrotechnik). Herr v. Groddeck. A comparison of its economy with that of the reciprocating engine. Ills. 4500 w. Die Turbine—Aug. 5, 1909. No. 7974 D.

Heating, Water-Heating, Power and Light with Exhaust-Steam Turbines (Heizung, Warmwasserbereitung, Kraftbetrieb und Beleuchtung mit Niederdruck-Dampfturbinen bei Abdampfausnutzung). Herr Tilly. A discussion of the economy of the low-pressure turbine, with costs. Ills. 2200 w. Gesundheits-Ing—Aug. 28, 1909. No. 7983 D.

The Utilization of Exhaust Steam in Collieries. C. B. Chartres. Abstract from Pro. of S. Wales Inst. of Engrs. Considers its use in low-pressure turbines for generating electricity. 3000 w. Ir & Coal Trds Rev—Aug. 20, 1909. No. 7447 A.

Turbine Speed.

See Gears, under MACHINE ELEMENTS AND DESIGN.

Water Hammer.

Water Hammer Action in Steam Pipes. Describes Mr. C. E. Stromeyer's experimental apparatus for studying water-hammer, and reviews his method of calculating stresses. Ills. 2500 w. Locomotive—July, 1909. No. 7507.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electric Suspension Railways (Ueber Elektrohängebahnen). M. Freyberg. Illustrates and describes a number of aerial-tramway installations for coal and ore handling. 2000 w. Glückauf—Aug. 21, 1908. No. 7964 D.

Cableways.

The Transport and Dumping of Material. Illustrated description of recently built plants of the Bleichert ropeway system. 800 w. Col Guard—Aug. 27, 1909. No. 7649 A.

Car Dumping.

Electrically Operated Coal Car-Dumping Plant at the Rothesay Dock, near Glasgow (Elektrisch betriebene Kohlenkipperanlage am Rothesay-Dock bei Glasgow). W. Schlachter. Illustrated description. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7998 D.

See also Coal Handling, under TRANSPORTING AND CONVEYING.

Coal Handling.

Recent Progress in Plants for the Rapid Loading and Unloading of Railway Cars (Recenti Progressi negli impianti per il Carico e lo Scarico accelerato dei Carri ferroviari). Giulio Pasquali. Describes recent plants for loading and dumping coal cars. Ills. 3000 w. Ing Ferro—Aug. 1, 1909. No. 7946 D.

See also Coal Pockets, under CIVIL ENGINEERING, CONSTRUCTION; and STEAMSHIPS, under MARINE AND NAVAL ENGINEERING.

Conveyors.

Transport of Filling-Up Material by the Harpener Bergbau-Gesellschaft, near Dartmund, Germany. Description of the conveying equipment. 1500 w. Min Jour —Aug. 28, 1909. No. 7642 A.

Cranes.

Calculation of Pillar Cranes. Charles A. Schranz. A study of the stresses in the boom and in the pillar and tie-bars, vertical tie-rods, foundation bolts, etc. 1500 w. Mach, N Y—Sept., 1909. No. 7499 C.

Building Slip Equipments. H. H. Broughton. Deals with the essentials in the crane equipment of a building slip. Ills. 2000 w. Elect'n; Lond—Aug. 27, 1909. No. 7645 A.

150-Ton Electric Shipbuilding Crane. Illustrated description of a crane recently completed at the Wallsend shipbuilding yard. 2000 w. Engr, Lond—Aug. 20, 1909. No. 7486 A.

75-Ton Steam Floating Crane for Montreal. Illustrated detailed description. 1000 w. Engng—Sept. 17, 1909. No. 8124 A.

150-Ton Swinging-Jib Cranes (Grues flottantes de 150-Tonnes, à Volée basculante). F. Hofer. Describes three types. Ills. 2000 w. Génie Civil—Aug. 28, 1909. No. 7939 D.

Dock Machinery.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XIe Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on dock machinery for ports handling inland traffic, particularly the progress of electrical control of dock and harbor machinery. 4800 w. Ann d Ponts et Chaussées—1909-IV. No. 7914 E + F.

Elevators.

The Safety Equipment of the Singer Building Elevators. Illustrates and describes the precautions taken for the protection of passengers from overspeed of travel and possibility of the car falling. 3000 w. Eng Rec—Sept. 11, 1909. No. 7674.

Electric Lift-Control Gear. Illustrated description of a form of lift control gear for direct-current working. 1600 w. Engng—Aug. 27, 1909. No. 7653 A.

Grain Handling.

See Grain Elevators, under MARINE AND NAVAL ENGINEERING.

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MISCELLANY.

Aeronautics.

The Parseval Airship. Plans and description of this dirigible airship recently approved by the Prussian War Office. 2000 w. Engng—Sept. 10, 1909. No. 7866 A.

Capt. Cody's British Army Aeroplane. Illustrated description of the machine which made a successful flight of over one hour, traveling 47 miles. 1200 w. Sci Am—Sept. 18, 1909. No. 7802.

On the Wright Flying-Machine—Concerning Its Construction and Mode of Working. An editorial letter from S. Tolver Preston. 1500 w. Engng—Sept. 3, 1909. No. 7753 A.

The Aeroplanes at Rheims. Describes the features of the different machines. 3300 w. Engr, Lond—Sept. 3, 1909. Serial. 1st part. No. 7758 A.

The Aeroplanes at Rheims and Their Records. Augustus Post. An illustrated review of important features of the trials. 2500 w. Am Mach—Vol. 32. No. 38. No. 8012.

The Rheims Aeronautical Meeting. A report of the meeting with illustrations of the aeroplanes. 1600 w. Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7662 A.

The Rheims Aviation Meeting. An illustrated account of the first great exhibition of dynamic flight. 2500 w. Sci Am Sup—Sept. 18, 1909. No. 7803.

Discussion on Aviation (Note complémentaire à la Discussion sur l'Aviation; Note relative à la Discussion sur l'Aviation). M. Armengaud and Rodolphe Soreau. A criticism of M. Soreau's paper and his reply. Ills. 8000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7907 G.

Tests of Stationary Aerial Propellers (Essais d'Hélices au Point fixe). M. A. Boyer-Guillon. Describes the method of testing and gives results obtained in the laboratory of the Conservatoire National des Arts et Météers. Ills. 8000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7905 G.

The Flight of Birds and Ornithoplanes (Le Vol de l'Oiseau et les Ornithoplanes). A. Etévé. A theoretical discussion of machines intended to imitate mechanically the flight of birds. Ills. Serial. 1st part. 3200 w. Génie Civil—Aug. 7, 1909. No. 7934 D.

See also Propellers, under MARINE AND NAVAL ENGINEERING.

Air Resistance.

Theory of the Resistance of Air to the Passage of Plates (Théorie de la Résistance à l'Avancement des Plaques dans l'Air). M. F. Chaudy. Derives a formula based on Eiffel's results. Ills. 6000 w. Mem Soc Ing Civ de France—Aug., 1909. No. 7906 G.

Clocks.

Telling Time by Automatic Machinery. Snowden B. Redfield. Illustrates and describes devices for keeping a number of clocks in uniform time, ringing bells at intervals, and various other automatic arrangements. 5500 w. Am Mach—Vol. 32. No. 39. No. 8200.

Empirical Formulae.

The Derivation of Empirical Formulas. John B. Peddle. Explains the derivation of equations to fit empirical data in the form of curves or charts. 9500 w. Am Mach—Vol. 32. No. 38. No. 8014.

Leibnitz.

The Work of Leibnitz in Physical Science and Technology (Leibnizens Arbeiten auf physikalischem und technischem Gebiet). E. Gerland. A brief historical review. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 14, 1909. No. 8151 D.

Mixing Machines.

The Laurica Mixing and Kneading Machine. Illustrated description of an ingenious machine for mixing all kinds of materials and for kneading dough. 1200 w. Engng—Aug. 20, 1909. No. 7444 A.

MINING AND METALLURGY.

COAL AND COKE.

Alabama.

Lahausage Mine, Alabama. A. W. Evans. Gives the location, geology and analysis of the coal, describing the plant and the method of mining. 2500 w. Mines & Min—Sept., 1909. No. 7489 C.

Analysis.

See Sampling, under COAL AND COKE.

Australia.

Powlett River Coalfield, Victoria. An account of coal discoveries estimated at over 20,000,000 tons. 3000 w. Aust Min Stand—Aug. 11, 1909. No. 8007 B.

Chile.

The Coalfields and Collieries of Chile. Archibald Russell. Outlines the coal deposits on the Pacific coast and gives information in regard to the quality of coal and the mining industry in Chile. 2500 w. Min Jour—Aug. 21, 1909. No. 7430 A.

Coal Cutting.

The Bar Electric Coal-Cutting Machine. Sydney F. Walker. Describes both the "Pick Quick" and "Simplex" machines and their operation. Diagrams. 2500 w. Mech Wld—Sept. 17, 1909. No. 8121 A.

Coke Ovens.

Genesis and Development of the Coking

Oven. W. Galloway. Read before the South Wales Inst of Engrs. Historical review. 3000 w. Can Min Jour—Sept. 1, 1909. No. 7550.

Electric Power.

Electrical Power Generation and Distribution at the Collieries of the Lochgelly Iron & Coal Co., Fife. John Paul. Abstract of a paper read before the Min. Inst. of Scotland. Illustrated description. 2500 w. Elect'n, Lond—Sept. 10, 1909. No. 7860 A.

England.

Geology of Lower Coal Measures of Derbyshire and Nottinghamshire. R. D. Vernon. Extracted from *Geol. Mag.* Discusses the evidence afforded by boreholes and sinkings for the presence of these lower coal measures. Ills. 1700 w. Col Guard—Aug. 27, 1909. Serial. 1st part. No. 7650 A.

Coal Mining Methods in England. Floyd W. Parsons. Illustrates and describes the methods and equipment at the Hulton Colliery. No explosives used. Ventilated by underground fans. 2500 w. Eng & Min Jour—Sept. 25, 1909. No. 8072.

Europe.

Brief Notes on European Coal Mines. Floyd W. Parsons. Considers some reasons why the coal industry abroad is on a more profitable basis. Ills. 1600 w. Eng & Min Jour—Sept. 11, 1909. No. 7679.

Explosions.

The Phenomena Preceding Gas Explosions. Francis Laur. A study of the relation of sidereal influences to gas explosions in mines. 3500 w. Eng & Min Jour—Sept. 11, 1909. No. 7680.

Mine Explosions as Related to Earthquakes. W. A. Spalding. Shows that an earthquake may cause an outflow of gas in a distant mine. 2500 w. Eng & Min Jour—Sept. 18, 1909. No. 7825.

Seismic Disturbances and Coal Mine Explosions. Audley H. Stow. A discussion of the possible effect of seismic disturbances on the accumulation of gas in coal and its extension into the workings. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7565.

Wehrum (Pa.) Mine Explosion. An account of the conditions existing at the mine at the time of the explosion, and the Coroner's verdict. 4000 w. Mines & Min—Sept., 1909. No. 7493 C.

Lignite.

See Peat, under COAL AND COKE.

Mine Dust.

Coal-Dust Experiments in the Testing Gallery of the Rossitz District (Versuche mit Kohlenstaub im Versuchstollen des Rossitzer Steinkohlenrevieres). Herrn Czaplinski and Jicinsky. Describes the tests and gives results. Ills. Serial. 1st past. Oest Zeitschr f Berg u Hüttenwesen—Aug. 28, 1909. No. 7963 D.

Coal Dust Experiments at the Experimental Gallery of the Rossitz Coalfield. Dr. Czaplinski and J. Jisinsky. Trans. from *Zeit. für Berg- und Hüttenwesen.* Describes experiments to determine the conditions under which coal dust is liable to explode. 800 w. Ir & Coal Trds Rev—Sept. 10, 1909. Serial. 1st part. No. 7871 A.

Mine Flushing.

The Flushing Problem in the Anthracite Region. Explains the situation in Pennsylvania, and the danger to surface property, describing the attempt to fill the spaces where coal has been removed. 1500 w. Eng & Min Jour—Sept. 18, 1909. No. 7826.

Mine Gas.

See Safety Lamps, under COAL AND COKE.

Mine Surveying.

See Surveying, under MINING.

New Zealand.

Description of a New Zealand Coal Mine. C. J. Holroyde. A general illustrated description of the plant of the Westport Stockton Coal Co.'s mine. 2500 w. Aust Min Stand—Aug. 18, 1909. No. 8141 B.

Peat.

Peat and Lignite. Erik Nyström. A review of their preparation and uses in Europe. Ills. 98500 w. Canada Dept of Mines—1908. No. 7821 N.

Investigation of the Peat Bogs and Peat Industry of Canada During the Season 1908-9. Erik Nyström and S. A. Anrep. Report of methods of investigation, with description of bogs and discussion of the present status of the peat industry. Maps. 10000 w. Canada Dept of Mines, Bul. No. 1, No. 30. No. 7820 N.

Philippines.

See Calorimetry, under MECHANICAL ENGINEERING, MEASUREMENT.

Rescue Stations.

The Rescue Station at Frameries, S. Stassart and J. Bolle, in *Ann. des Mines de Belgique.* Illustrated description of the station installed and equipped by the Belgian government. 2000 w. Col Guard—Sept. 10, 1909. No. 7862 A.

Royal Commission Report.

Royal Commission on Mines. Abridgement of the second report. 21000 w. Col Guard—Sept. 17, 1909. Serial. 1st part. No. 8122 A.

Russia.

The Coal Fields of Russia. Dr. Robert Grimshaw. Brief review of the coal deposits and mines. 1000 w. Min Wld—Sept. 4, 1909. No. 7549.

Safety Lamps.

Firedamp Caps and the Detection of Firedamp in Mines by Means of Safety Lamps. Two papers by E. Bessell Whalley, and G. R. Thompson, discussed together at meeting of Inst. of Min. Engrs.

We supply copies of these articles. See page 323.

6500 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8137 A.

Sampling.

Sampling and Analyzing of Coal. Explains the method used by the U. S. Geol. Survey, which involves a determination of everything that affects heat value. 3000 w. Power—Sept. 21, 1909. No. 7874.

United States.

The Coal Mining Industry of the United States in 1908. Condensed from information furnished by the U. S. Geol. Survey. 2000 w. Eng News—Sept. 2, 1909. No. 7542.

Testing Stations.

United States Testing Station at Pittsburg. Description, with plan and section of the gas and dust gallery. Ills. 4500 w. Col Guard—Aug. 27, 1909. No. 7651 A.

Wales.

No. 3 Pit, Bwllfa Colliery. An illustrated description of a modernized plant recently installed. 1700 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7665 A.

COPPER.

Alloys.

The Influence of Bismuth on Wire-Bar Copper. H. N. Lawrie. Reviews the conclusions of other investigators and reports the author's tests and conclusions. 3000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8197 F.

Arizona.

The Southern Arizona Copper Fields. C. F. Tolman, Jr. Describes the ore occurrences and their relation to the local geology, and the mining methods. Ills. 3600 w. Min & Sci Pr—Sept. 11, 1909. No. 7831.

The Miami Copper Mine, Arizona. R. L. Herrick. Illustrates and describes the mine development and mining methods. Creosoted timbers are used in shafts and drifts. 5800 w. Mines & Min—Sept., 1909. No. 7490 C.

Assaying.

Accuracy in Assays and Analyses. James W. Howsor. Gives tabulated results in duplicate of most of the elements usually determined in ore analyses, with information relating to analytical work. 1500 w. Min & Sci Pr—Sept. 4, 1909. No. 7691.

Australia.

Gold and Copper Deposits, Phillips River (W. A.). H. P. Woodward. A detailed description of these ore deposits. 2000 w. Aust Min Stand—Aug. 11, 1909. Serial. 1st part. No. 8006 B.

Nevada.

The Yerrington Copper Deposits. Frederick Leslie Ransome. Abstract of Bul. No. 380-B, U. S. Geol. Surv. Explains the distribution of the mines, classifies the deposits and describes some of the mines. Map. 4000 w. Mines & Min—Sept., 1909. No. 7491 C.

Ore Bedding.

Cananea Ore-Bedding System. R. L. Herrick. An illustrated article describing the method of mechanically making up ore beds and charging ore from them into furnaces. 4500 w. Mines & Min—Sept., 1909. No. 7487 C.

Slags.

Metal-Losses in Copper-Slags. Lewis T. Wright. A study of the ratio of metals in the products of smelting. 1000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8194 F.

Smelter Flues.

Flue Construction and the Saving of Flue Dust. J. B. Wynne. Illustrates and describes a fume collector designed for and adopted by the Silberhütte smeltery. 2500 w. Eng & Min Jour—Sept. 25, 1909. No. 8074.

Smelter Fumes.

Method of Treating Corrosive Gaseous Fumes. Clarence B. Sprague. Describes an invention which aims to remove the corrosive constituents and fume from the smoke before it is discharged into the atmosphere. 1500 w. Min Wld—Sept. 11, 1909. No. 7613.

Tasmania.

Notes on the Geology of Mt. Lyell, Tasmania. Hartwell Conder. Describes aspects of the geology of the North Lyell mine, and discusses the location of the main mass of the ore body. 2500 w. Aust Min Stand—Aug. 11, 1909. No. 8005 B.

GOLD AND SILVER.

Australia.

Australia's Neglected Gold Fields. John Plummer. Information concerning abandoned mines that might be made productive. 1400 w. Min Wld—Sept. 18, 1909. No. 7836.

The Starcke Goldfield. Lionel C. Ball. Illustrated detailed description of an almost abandoned field in Queensland. 5500 w. Queens Gov Min Jour—Aug. 14, 1909. Serial. 1st part. No. 8140 B.

See also same title, under COPPER.

California.

The Alleghany Mining District, California. A. H. Martin. Illustrated description of the development of this new gold district. 2000 w. Min Wld—Sept. 18, 1909. No. 7835.

Cyaniding.

A Proposed New System for the Cyanide Treatment of Slimes. Ferdinand McCann. Describes a "dilution system" which consists of a series of slime thickeners, following the agitation tanks, with a dilution of the thickened pulp as it enters each thickener. 2500 w. Can Min Jour—Sept. 15, 1909. No. 7876 A.

Usher Sands Process for Extraction of Gold. Illustrated description of plant for the Adair-Usher mechanical process, and

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the procedure of the treatment. 2200 w. Aust Min Stand—Aug. 4, 1909. No. 7634 B.

Dredging.

Development of Modern Gold Dredgers. Describes special features of a propulsion screen gold dredger for Peru. 700 w. Engr, Lond—Sept. 10, 1909. No. 7869 A.

Gold Placers Dredging Operations in California. A. H. Martin. Illustrates and describes dredges used and reviews the advances in construction. 3500 w. Min Wld—Sept. 25, 1909. No. 8082.

Dredging at Breckenridge, Colorado. A. H. Bradford and Roy P. Curtis. Thesis. Describes briefly the geology of the region and the extensive placer deposits; reviews past operations and the causes of their failure; and describes present methods and results. Ills. 4400 w. Min & Sci Pr—Sept. 11, 1909. No. 7832.

Dutch East Indies.

Gold Mining Industry in the Dutch East Indies. E. A. Winton. Discusses the reasons for the retarded development, describing the most important mines. 2000 w. Map. Eng & Min Jour—Sept. 11, 1909. No. 7682.

France.

The Kalgoorlie Dry Crushing & Roasting Process in Operation in Central France. W. E. Simpson. An interesting account of the discovery of Chatelet mine, its location, and ore treatment. Ills. 1600 w. Min Jour—Aug. 28, 1909. No. 7641 A.

Nevada.

Notes on the Pioche Mining District, Nevada. S. F. Shaw. An illustrated account of renewed activity at mines unsuccessful in the past because of the high cost of treating the ores. 3000 w. Eng & Min Jour—Sept. 18, 1909. No. 7822.

Precipitation.

Zinc-Box White Precipitates. Roy F. Coolidge. Gives analyses of two kinds of white precipitate, and discusses the causes of the formation. 1600 w. Min & Sci Pr—Sept. 18, 1909. No. 8034.

Rand.

The Origin of the Rand Gold Fields. G. A. Denny. Discussion in connection with Prof. Gregory's paper. 5000 w. Ec Geol—Aug., 1909. No. 7889 D.

President's Valedictory Address. E. J. Laschinger. Discusses the engineering and industrial progress of South Africa, especially the gold-mining industry. 7500 w. Jour S African Assn of Engrs—July, 1909. No. 7636 F.

IRON AND STEEL.

Alabama.

The Gray Ores of Talladega County, Ala. John Jermain Porter. Information concerning the iron resources of the state, describing the character of the ores, and the condition of the iron industry. 2500 w. Mfrs Rec—Sept. 16, 1909. No. 7763.

Analysis.

The Analysis of Chrome-Tungsten Steel (Zur Analyse von Chrom-Wolfram-Stahl). F. W. Hinrichsen and Th. Dieckmann. Results of test at the Imperial Testing Bureau in Germany. Ills. 2300 w. Stahl u Eisen—Aug. 18, 1909. No. 7955 D.

See also Assaying, under COPPER.

Blast-Furnace Operation.

Fuel Economy in the Blast Furnace (La Valeur du Combustible dans les Fours à Cuve et en Particulier dans le Haut-Fourneau). Joseph von Ehrenwerth. A discussion of the utilization of the heat energy of the fuel charged in blast-furnace practice. 6500 w. Rev de Métal—Aug., 1909. No. 7918 E + F.

Blast Furnaces.

Development in the Size and Shape of Blast-Furnaces in the Lehigh Valley, as Shown by the Furnaces at the Glendon Iron Works. Frank Firmstone. 4000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8195 F.

Blast-Furnace Slag.

The Influence of Chemical Composition on the Hydraulicity of Slags (Schmelzversuche zum Nachweis des Einflusses der chemischen Zusammensetzung auf Hydraulizität der Schlacken). H. Passow. Gives results of an elaborate series of tests. 3800 w. Stahl u Eisen—Aug. 18, 1909. No. 7953 D.

Blowing Engines.

Recent Steel Works Blowing Engines (Neuere Stahlwerk-Gebläsemaschinen). C. Michenfelder. Describes recent machines built by the German firm of Ludwig Stuckenholz. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 28, 1909. No. 8155 D.

Electrometallurgy.

Report of the Investigation of an Electric Shaft Furnace, Domnarfvet, Sweden. Eugene Haanel. Also chapters descriptive of the manufacture of electrodes, and of the latest types of charcoal furnaces, with appendices on the progress of electric smelting in Norway and Sweden. Ills. 7500 w. Canada Dept of Mines. No. 32. No. 7786 N.

Pig Iron Production in an Electric Shaft Furnace. Illustrated account of investigations at Domnarfvet, Sweden, by Dr. Eugene Haanel. 5000 w. Ir Age—Sept. 16, 1909. No. 7766.

Actual State of the Electro-Metallurgy of Iron (Etat actuel de l'Electro-Métallurgie du Fer). M. Henry. A review of achievements and present practice. Ills. Serial. 1st part. 2500 w. Elecn—Aug. 14, 1909. No. 7928 D.

Ferro-Alloys.

Ferro-Manganese in the Blast Furnace. O. Höhl, in *Stahl und Eisen*. Information with reference to successful work in South Russia. 1200 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7666 A.

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The Poisonous Gases Liberated from Ferro-Silicon in Damp Air (Sur les Gaz toxiques dégagés par les Ferrosiliciums sous l'Action de l'Air humide). Paul Labeau. Results of investigations of their composition and liberation. 3500 w. Rev de Métal—Aug., 1909. No. 7919 E + F.

Ingot Compression.

Rail Rolling Methods. James E. York. Gives reasons why a steel ingot cannot be solidified during the rolling in the blowing mill, and describes the York method of solidifying the ingot. Ills. 1800 w. Ir Age—Sept. 16, 1909. No. 7767.

Nova Scotia.

Report on the Iron Ore Deposits of Nova Scotia. J. E. Woodman. General considerations, with details of iron districts. Maps and Ills. 88500 w. Canada Dept of Mines—No. 20. No. 7819 N.

Ontario.

Report on the Examination of Some Ore Deposits in the Districts of Thunder Bay and Rainy River, Province of Ontario. F. Hille. 3500 w. Ir Trd Rev—Sept. 16, 1909. No. 7791.

The Iron and Steel Industry of the Province of Ontario, Canada. Jas. Grannis Parmelee. An illustrated article giving an outline of the more important plants. 8000 w. Ir & Coal Trds Rev—Aug. 27, 1909. No. 7664 A.

Rolling Mills.

Manganese Steel Products. Illustrates and describes progress with the Potter process of rolling as employed at Paterson, N. J. 2500 w. Ir Age—Sept. 30, 1909. No. 8199.

Power Required for Rolling Mills. J. A. Knesche. Discusses a method for determination of most economical size of power generator for rolling mills. Ills. 3000 w. Ir Trd Rev—Sept. 2, 1909. Serial. 1st part. No. 7543.

Electric Reversible Blooming Mill at the Rhine Steel Works, Duisbourg-Meiderich (Train blooming réversible électrique des Aciéries du Rhin, à Duisbourg-Meiderich). Illustrated description, with power-consumption data. 2500 w. Génie Civil—Aug. 21, 1909. No. 7937 D.

Tests of a Steam-Driven Reversing Ingot Roll Train (Betriebsversuch an einer Dampf-Umkehrblockstrasse). Results of elaborate power consumption tests. Ills. 2500 w. Stahl u Eisen—Aug. 25, 1909. No. 7956 D.

See also Ingot Compression, under IRON AND STEEL; and Electric Hoisting, under MINING.

Steel Works.

Electric Power Problems in Steel Plants. R. Tschentscher. Considers the problems in connection with the various classes of steel mills, and some of the complications. 3500 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8179 F.

A East Indian Iron and Steel Plant. Illustrated description of the works of the Tata Iron and Steel Co., Ltd., at Sakchi, India, now under construction. 3000 w. Ir Age—Sept. 23, 1909. No. 8004.

LEAD AND ZINC.

Lead Smelting.

Smelting Refractory Lead Ores at Laurium. L. Guillaume. Abstract trans. from *Ann. des Mines*. Describes details of a new lead furnace for treating low-grade ores. Ills. 2000 w. Eng & Min Jour—Sept. 4, 1909. No. 7564.

MINOR MINERALS.

Aluminium.

The Electrical Reduction of Aluminium, a Laboratory Experiment (Die elektrische Reduktion des Aluminiums, ein Laboratoriums-Experiment). F. Bock. Describes the experiments and gives results. Ills. 2000 w. Elektrochem Zeitschr—Aug., 1909. No. 7947 D.

Cement.

Investigating Marl Deposits for Portland-Cement Making. Fred. Fisher. Examines the factors and conditions that determine the value of such deposits. 1200 w. Engineering Magazine—Oct., 1909. No. 8177 B.

Philippine Raw Cement Materials. Alvin J. Cox. Information relating to materials and their location, and the fuel for burning cement. 4500 w. Philippine Jour of Sci—May, 1909. No. 7790 N.

Gas Firing for Lime and Cement Kilns. Oscar Nagel. An illustrated article presenting the advantages of gaseous over solid fuels. 1600 w. Cassier's Mag—Sept., 1909. No. 7777 B.

Chromite.

Report on the Chrome Iron Ore Deposits in the Eastern Townships, Province of Quebec. Fritz Cirkel. Gives the history of chrome iron ore, describing the deposits, mining, dressing, origin, value, etc. Illustrations. 52500 w. Ills. Canada Dept of Mines—No. 29. No. 7787 N.

Diamonds.

Petrographic Note on the Diamond-Bearing Peridotite of Kimberley, South Africa. Victor Hartog. A microscopic study, with a bibliography of the subject by A. A. Julian. Ills. 9000 w. Ec-Geol—Aug., 1909. No. 7888 D.

Graphite.

Graphite Mining Near La Colorado, Sonora, Mexico. Frank L. Hess. An illustrated account of the deposits, methods and product. 3500 w. Engineering Magazine—Oct., 1909. No. 8173 B.

Gypsum.

Gypsum on Cape Breton Island, Nova Scotia. John Tyssowski. Map and description of the deposits, and operations. 1200 w. Eng & Min Jour—Sept. 18, 1909. No. 7827.

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Lime.

See Cement, under MINOR MINERALS.

Natural Gas.

Natural Gas for Baltimore. C. F. Uebelacker. Report to a committee of the Baltimore city council. Briefly considers methods of manufacture of artificial gas, its properties, price, etc. Natural gas, its lighting, and heating value, cost, mixed gas, etc. 2500 w. Pro Age—Sept. 15, 1909. No. 7764.

Niobium.

A New Rapid Volumetric Method for the Determination of Niobium in the Presence of Tantalum and Its Application to the Analysis of Niobium Minerals. F. J. Metzger and C. E. Taylor. A report of experimental work. 3500 w. Sch of Mines Qr—July, 1909. No. 7892 D.

Nitrate.

The Nitrate Deposits of Chile. Gilmour E. Brown. Describes the deposits, discussing their origin, process of extraction, etc. Ills. 5000 w. Min Jour—Aug. 28, 1909. No. 7640 A.

Salt.

The Rock-Salt Mining Industry in Kansas. Samuel Ainsworth. Describes the mining and milling methods employed. Ills. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7566.

Notes on the Evaporated Salt Industry of Kansas. C. M. Young. Describes the operations of the Joy-Morton and the Cary companies. Ills. 3000 w. Eng & Min Jour—Sept. 18, 1909. No. 7824.

Salt Deposits and Mining in German East Africa (Salzvorkommen und Salzgewinnung in Deutsch-Ostafrika). Herr Ernst. A brief review of the industry. 1800 w. Glückauf—Aug. 28, 1909. No. 7965 D.

Sulphur.

Sulphur Mining in Mexico. Edward F. White. Describes the occurrence of the ore and the methods employed in mining and refining. Ills. 2700 w. Mines & Min—Sept., 1909. No. 7488 C.

Tin.

Mining Operations in the Tin Mines of Cornwall. R. H. Conran. Abstract of a paper read before the Sci. Soc., Broken Hill, N. S. W. Illustrates and describes methods used. 3000 w. Min Wld—Sept. 11, 1909. No. 7711.

Tripoli.

Tripoli Deposits at Seneca, Missouri. Gaylord Nelson. Describes these deposits, discussing their origin, methods of mining, etc. 1500 w. Min Wld—Sept. 11, 1909. No. 7712.

Tungsten.

Occurrence and Utilization of Tungsten Ores. A résumé of information available on this subject. 5500 w. Bul Imp Inst—Vol. VII. No. 2. Serial. 1st part. No. 8033 N.

Tungsten: Its Uses and Geological Occurrence. T. L. Walker. Abstracted from report made to the Dept. of Mines, Canada. Describes the chief tungsten ores and general chemical tests, their occurrence and concentration. 3000 w. Min Wld—Sept. 11, 1909. No. 7710.

Report on the Tungsten Ores of Canada. T. L. Walker. General review of the metal and its uses, ores, occurrence, tests, distribution, etc. Ills. 13500 w. Canada Dept of Mines—No. 25. No. 7782 N.

MINING.

Diamond Drilling.

Notes on Diamond Drilling at the Michigan Copper Mine, Rockland, Mich. Clarence M. Haight. Detailed account of the work, with condensed summary and analysis including costs. 1200 w. Sch of Mines Qr—July, 1909. No. 7890 D.

Drilling.

Machine Drilling and Blasting (Maschineller Bohrbetrieb und Zeitzündung). V. Lipold. Describes a new Siemens & Halske fuse and gives comparative costs of breaking ground by hand and machine drilling. Ills. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 21, 1909. No. 7962 D.

Electric Hoisting.

Load Compensation for Hoisting Machines and Rolling Mills (Belastungsausgleich bei Fördermaschinen und Walzwerken). Josef Blazek. Discusses electrical systems of load equalization. Ills. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 14, 1909. No. 7961 D.

Electric Power.

Electrical Wiring for Deep Mining Work. Carl L. C. Fichtel. The mechanical and electrical features are considered. 2200 w. Eng & Min Jour—Sept. 11, 1909. No. 7683.

See also Mine Regulations, under MINING.

Explosives.

Principles and Compositions of Explosives. A. L. Hodges. An explanation of the principle, and a discussion of the composition of the most used explosives. 2800 w. Min Wld—Sept. 4, 1909. No. 7548.

Gravity Planes.

Self-Acting Top for Gravity Plane. H. McKean Conner. Illustrated description of a device by which cars may be delivered and received on tracks of different grades. 800 w. Mines & Min—Sept., 1909. No. 7494 C.

Labor.

Labor Efficiency in Mining Operations. Peter B. Scotland. Discusses some of the factors that contribute toward efficiency. 1200 w. Eng & Min Jour—Sept. 11, 1909. No. 7685.

Methods.

Modern Progress in Mining and Metal-

lurgy in the Western United States. David W. Brunton. Presidential address giving an outline of recent improvements and the present situation. 7000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8196 F.

Mining and Metallurgy in Western United States. David W. Brunton. Abstract of presidential address to the Am. Inst. M. E., at Spokane. On recent and important improvements in mining practice. 6500 w. Min Wld—Sept. 25, 1909. No. 8083.

Mine Regulations.

Electricity Rules in New South Wales Mines. Gives text of special rules established in most of the large collieries where electrical installations exist. 7000 w. Ir & Coal Trds Rev—Sept. 3, 1909. No. 7761 A.

Power Plants.

See Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pumping.

Electrical Mine-Pumps in Europe. A. S. Atkinson. Information in regard to types, efficiency and operation. 2000 w. Min & Sci Pr—Sept. 4, 1909. No. 7693.

Shaft Lining.

An Account of the Method Employed in Stopping an Extensive Leak, Under High Pressure, in the Tubbing of the East Pit, Murton Colliery, 1907. W. O. Wood. 2000 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8138 A.

Shaft Sinking.

Sinking Concrete Shafts. Abstract of a paper by F. W. Adgate read at meeting of L. Superior Min. Inst., describing methods used. 2500 w. Eng Rec—Sept. 4, 1909. No. 7557.

Sinking a Reinforced Concrete Mine Shaft. Albert H. Fay. Illustrated account of work at the Morton Mine, Minnesota, where a circular shaft, 21 ft. in diameter, was sunk through 190 ft. of water-bearing strata. 1500 w. Eng & Min Jour—Sept. 15, 1909. No. 8073.

Sinking Through Sand at Newbiggin Colliery. E. M. Bainbridge and Walter M. Redfearn. Describes the sinking by the drop-shaft method. 3500 w. Ir & Coal Trds Rev—Sept. 17, 1909. No. 8139 A.

Signalling.

Electric Signalling in Mines. Illustrates and describes the Siemens system. 2500 w. Ir & Coal Trds Rev—Aug. 20, 1909. No. 7448 A.

Surveying.

Colliery Surveys. D. Harrington. Describes the methods of surveying and mapping surface work used in the rocky mountain region. 5000 w. Mines & Min—Sept., 1909. Serial. 1st part. No. 7492 C.

ORE DRESSING AND CONCENTRATION.

Classification.

Free and Hindered Settling of Mineral Grains. Arthur O. Christensen. Discusses the theory and principles as applied to ore classification. Ills. 4800 w. Eng & Min Jour—Sept. 11, 1909. No. 7681.

Crushing.

Practical Notes on Dry Crushing Mills. M. W. von Bernewitz. Gives practical experience with sulpho-telluride ore at Kalgoorlie, W. Aust. 3500 w. Min Jour—Sept. 4, 1909. No. 7742 A.

Gold Milling.

Treatment of Sulphide Ores in Victoria. S. Radcliff and J. Drevermann. Abstract from Pro. of Aust. Inst. of Min. Engrs. Describes experiments made to determine the associated minerals, gain information as to the cause of volatilization loss, and to find out whether satisfactory extraction could be made without roasting. 1500 w. Min & Sci Pr—Sept. 11, 1909. No. 7833.

Simmer Deep and Jupiter Reduction Works. J. E. Thomas. Illustrated description of joint works in South Africa, and the processes followed. 3000 w. Min & Sci Pr—Sept. 18, 1909. No. 8035.

Boston-Sunshine Mill. G. W. Wood. Describes a reconstructed plant and the processes used in treating the gold ores. 1200 w. Min & Sci Pr—Aug. 28, 1909. No. 7512.

Lead Milling.

The Concentration of Silver-Lead Ores at the Works of Block 10 Co., Broken Hill, N. S. W., Australia. V. F. Stanley Low. Gives an outline of the system employed and details of operation. Ills. 4000 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8192 F.

Slimes Treatment.

See Vanners, under ORE DRESSING AND CONCENTRATION; and Cyaniding, under GOLD AND SILVER.

Stamp Mills.

The Development of Heavy Gravitation Stamps. W. A. Caldecott. An illustrated discussion of the development and of some of the factors affecting present-day stamp-milling, showing the advantages of heavy stamps. 4000 w. Inst of Min & Met, Bul. No. 59—Aug. 12, 1909. No. 7784 N.

Some Notes on the Construction and Operation of the Gravity Mill. G. H. Fison. Detailed discussion. 2500 w. Min Jour—Sept. 4, 1909. No. 7741 A.

Practical Working of the Stamp Mill. Algernon Del Mar. Discusses important details of construction and related matters. 2000 w. Eng & Min Jour—Sept. 18, 1909. No. 7823.

Tailings.

Impounding Mill Tailing. H. W. MacFarren. Suggestions for carrying out the purposes in view. Ills. 700 w. Min & Sci Pr—Sept. 4, 1909. No. 7692.

Vanners.

The Treatment of Slime on Vanners. Rodolf Gahl. A report of tests made by

the Detroit Copper Mining Co. to determine whether it would pay to retreat slime-tailings. 5500 w. Bul Am Inst of Min Engrs—Sept., 1909. No. 8193 F.

MISCELLANY.

Algeria.

The Mining Industry in Algeria and Tunisia. M. Clère. An account of the mining of iron, lead, zinc, and phosphates, and matters affecting the industry. 3500 w. Eng & Min Jour—Sept. 4, 1909. No. 7567.

Alloys.

The Industrial Alloys of Chromium (Les Alliages industriels de Chrome). Jean Escard. Brief notes on the alloys of chromium with silicon, aluminium, nickel, tin, manganese, copper, tungsten and vanadium. Ills. 5600 w. Rev Gen des Sci—Aug. 15, 1909. No. 7922 D.

Mexico.

Geology of Northern Mexico. R. H. Burrows. Divides the territory into three regions; the present number describes the Eastern. Ills. 4000 w. Min & Sci Pr—Aug. 28, 1909. Serial. 1st part. No. 7511.

Ore Deposits.

Some Phenomena of the Folding of Rock Strata. Frank L. Nason. A study of rock formation in the Rocky Mts. and their extension into Mexico, their mineralization and related subjects. 4500 w. Ec-Geol—Aug., 1909. No. 7887 D.

Porto Rico.

Notes on Some Ore Deposits of Porto Rico. S. Harbert Hamilton. Notes on the topography and geology of the island, describing the iron, copper, and other deposits. Ills. 1200 w. Eng & Min Jour—Sept. 11, 1909. No. 7684.

Refractory Materials.

Conductivity, Porosity, and Gas Permeability of Refractory Materials. S. Wologdine and A. L. Queneau. Deals with the conductivities of a number of refractory materials in the present article. 2500 w. Elec-Chem & Met Ind—Sept., 1909. Serial. 1st part. No. 7591 C.

South America.

A Review of Mining in Latin America. 2500 w. Min Jour—Sept. 4, 1909. No. 7740 A.

Sulphuric Acid.

Sulphuric Acid Lead Chamber Construction. Frederic J. Falding. Illustrates and describes the principle of a modern type of chamber, claiming increased efficiency. 2500 w. Eng & Min Jour—Sept. 4, 1909. No. 7563.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

A Trainmaster's View Point. Fred C. Letts. Explaining some of the difficulties encountered. 3000 w. R R Age Gaz—Sept. 10, 1909. No. 7697.

Signalling.

The Maintenance of Mechanical Interlocking. T. W. Triplett. Suggestions for the inspection and maintenance of the plant. 2500 w. Sig Engr—Sept., 1909. No. 7829.

Systematic Signaling. C. C. Anthony. Discusses the standard codes of block signals and interlocking rules, and the proposals submitted by the Signal and Maintenance of Way Assns. 5000 w. R R Age Gaz—Sept. 10, 1909. No. 7695.

An Automatic Electric Fog-Signaling Apparatus for Railroads. Illustrated description of an apparatus being experimented with on the Belgian State Railways. 900 w. Sci Am—Sept. 18, 1909. No. 7801.

The Latest System of Power Railway Signalling. Illustrations and brief description of an all electric plant at Yarnton, near Oxford, on the Gt. Western Ry. 500 w. Engr, Lond—Aug. 27, 1909. No. 7663 A.

Electric Interlocking at the Orléans Station (L'Exécution d'Enclenchements provisoires par Serrures électriques sur le Réseau d'Orléans). M. Jullien. Describes an installation on the Bouré system. Ills. 2000 w. Rev Gen de Chemins de Fer—Aug., 1909. No. 7924 G.

Train Staff.

Train Staff Installation on the N. Y., N. H. & H. W. F. Follett. Illustrated description. 1200 w. Sig Engr—Sept., 1909. No. 7830.

MOTIVE POWER AND EQUIPMENT.

Air-Brake Valves.

H6 Distributing Valve Test. Describes tests to determine the condition and locate defects. Ills. 2500. Ry & Loc Engng—Sept., 1909. No. 7578 C.

Electrification.

The Choice of a System of Electrification for Trunk Lines. C. L. de Muralt. Discusses only lines now operated by steam, investigating the merits of the four electric systems and comparing them. Discussion. 5400 w. Pro Am Inst of Elec Engrs—Sept., 1909. No. 8148 F.

The Introduction of Electric Traction on Main-Line Railways. E. Frischmuth. Report of a paper read before the Elektrotechnische Verein. Discusses the advantages, working, maintenance, system, etc. Ills. 11500 w. Bul Int Ry Cong—Aug., 1909. No. 8030 G.

We supply copies of these articles. See page 323.

Freight Cars.

Fifty Ton Steel Gondola Car. Drawings and description of cars for the Norfolk & Western Ry. 500 w. Am Engr & R R Jour—Sept., 1909. No. 7574 C.

21-Ton Self-Discharging Wagon. Brief illustrated description of cars for service on the Burma Railways. 400 w. Engr, Lond—Sept. 10, 1909. No. 7870 A.

Locomotive Axle Loads.

Distribution of Locomotive Axle-Loads, in Relation to Bridges. James Dudley Ward Ball. Compares different engines of various types to ascertain which produces a minimum bending moment. Diagrams. 2500 w. Inst of Civ Engrs—No. 3816. No. 8168 N.

Locomotive Boilers.

The Modern Locomotive Boiler. John W. Hobson. Read before the Graduate Sec. of the N.-E. Coast Inst. of Engrs & Shipbldrs. Introductory remarks with consideration of questions of design. Ills. 3500 w. Mech Engr—Sept. 17, 1909. Serial. 1st part. No. 8119 A.

Improvements in Locomotive Boilers. Mr. Nadal. Report for Belgium, Spain, France, Italy, and Portugal. 12500 w. Bul Int Ry Cong—July, 1909. No. 8022 G.

Boiler Check Valves and Feed Water Delivery Pipes. Extracts from a paper by J. D. Emerson, read before the Traveling Engrs.' Assn. 1400 w. Ry & Engng Rev—Sept. 11, 1909. No. 7616.

Locomotive Design.

A Diagram for Determining the Relation Between Cylinder Power and Heating Surface. Lawford H. Fry. Gives diagram and explanation. 500 w. Am Engr & R R Jour—Sept., 1909. No. 7573 C.

Locomotive Economy.

Fuel Economy. Extracts from a paper by S. D. Wright read before the Traveling Engrs.' Assn. Considers fuel-saving devices, waste coal, boilers and their care, etc. 4000 w. Ry & Engng Rev—Sept. 11, 1909. No. 7717.

Locomotive Failures.

Locomotive Failures with Walschaert Valve Gear. Extracts from a report to the Traveling Engrs.' Assn. Outlines steps to be taken in case of a failure of any part while on the road. 1800 w. Ry & Engng Rev—Sept. 11, 1909. No. 7615.

Locomotive Repairs.

Repairs to Locomotives by Contract Shops. Discusses questions relating to economy and the kind of repairs that could be adapted to outside repair arrangement. 3500 w. R R Age Gaz—Sept. 3, 1909. No. 7585.

Locomotives.

Simple *v.* Compound: A Footplate Experience. A comparison based on coal consumption, showing the compound to be superior. 3500 w. Engr, Lond—Aug. 20, 1909. No. 7485 A.

Ten-Wheel Locomotives for Brazil. Illustrates and describes two designs recently built. 1000 w. Ry & Engng Rev—Sept. 25, 1909. No. 8085.

Eight-Wheel Engines, Western Ry. of Havana. Illustrated description of engines equipped with fire tube superheater with side headers. 1000 w. Ry & Engng Rev—Sept. 4, 1909. No. 7551.

New Locomotives for the Natal Government Railway. Illustrations and description of engines remarkable for their size and power, and having many interesting features. 1500 w. Mech Engr—Sept. 17, 1909. No. 8116 A.

Locomotive History on the B. & M. W. A. Hazelboom. A brief sketch of the development of the locomotive on the Bosotn & Maine R. R. 2500 w. Ry & Loc Engng—Sept., 1909. No. 7581 C.

Minneapolis and St. Louis Engines. Illustrated brief descriptions of types. 800 w. Ry & Loc Engng—Sept., 1909. No. 7580 C.

Mallet Articulated Compound Locomotives, 2-6-6-0 Type, and Switching Locomotives 0-8-0 Type. Drawings and description of engines for the Virginian Railway. 2800 w. Am Engr & R R Jour—Sept., 1909. No. 7576 C.

A New American Articulated Locomotive (Eine neue amerikanische Gelenklokomotive). Bruno Schwarze. Describes a new Mallet compound for the Great Northern. Ills. 2500 w. Glasers Ann—Aug. 1, 1909. No. 7079 D.

Creusot Water-Tube, Eight-Wheeled, Coupled, Compound Locomotive (Locomotive-Tender compound à Chaudière aquatubulaire et à huit Roues couplées, des Etablissements du Creusot). Illustrated description. Plate. 3000 w. Génie Civil—Aug. 28, 1909. No. 7940 D.

New Compound Six-Wheeled Coupled Locomotive of the Northern Railway of France (Nouvelle Locomotive compound à trois Essieux couplés et à Roues motrices de 1m.75 de la Compagnie du Chemin de Fer du Nord). Illustrated description. 1200 w. Rev Gen des Chemins de Fer—Aug., 1909. No. 7923 G.

Machinery Exhibits at the Munich Exposition, 1908 (Die Maschinen auf der Ausstellung München 1908). G. Guillery. Devoted principally to the locomotive exhibits. Ills. 3000 w. Glasers Ann—Aug. 1, 1909. No. 7979 D.

Locomotive Stokers.

Mechanical Stokers. Editorial on the reports of the present year of committees of the Master Mechanics' Assn. on mechanical stokers for locomotives. 1600 w. R R Age Gaz—Sept. 3, 1909. No. 7584.

Locomotive Superheaters.

Superheaters for Locomotives—Some Forgotten Applications (Cenni storici e descrittivi su Alcune antiche e sconos-

We supply copies of these articles. See page 323.

cinte Applicazioni del Surriscaldamento alle Locomotive a Vapore). Charles R. King. Reprinted from *Ingegneria Ferroviaria.* Ills. 15000 w. Ing Ferro—1909. No. 7975 F.

Operating Associations.

Railway Operating Associations. W. F. Allen. Address at Harvard Univ. Reviews the causes that led to their formation, and outlines their history. 15700 w. Bul Int Ry Cong—July, 1909. No. 8025 G.

Shops.

Locomotive Repair Shop of the Missouri, Kansas & Texas at Parsons, Kansas. Illustrated description of a new western shop with a longitudinal erecting shop. Plate. 1000 w. R R Age Gaz—Sept. 3, 1909. No. 7588.

Locomotive and Passenger Car Shops of the Frisco System at Springfield, Mo. Plans, illustrations, and description of extensive new shops and their equipment. 2000 w. R R Age Gaz—Sept. 3, 1909. No. 7586.

Train Resistance.

The Traction of Freight Trains at Different Speeds. Clinton S. Bissell. Explains the development of equations and curves showing weights of freight trains for various speeds and car weights on 1% and 3% grades. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1909. No. 8181 E.

Valve Gears.

See Locomotive Failures, under MOTIVE POWER AND EQUIPMENT.

NEW PROJECTS.

Nigeria.

Railways in Northern Nigeria. Describes the conditions existing and the railways under construction. Plate. 2500 w. Engr, Lond—Sept. 17, 1909. No. 8131 A.

PERMANENT WAY AND BUILDINGS.

Bridges.

Guard Rails and Deck Construction for Railway Bridges. Information concerning prevailing practice, especially on American railways. Also editorial. Ills. 9000 w. Eng News—Sept. 9, 1909. No. 7624.

See under CIVIL ENGINEERING, BRIDGES; and Track Construction, under PERMANENT WAY AND BUILDINGS.

Cable Railways.

Determining the Profile of a Cable Railway for Uniform Speed, Taking Into Consideration the Weight of the Rope (Bestimmung des Profils einer Seilbahn, auf der unter Mitberücksichtigung des Gewichtes des Drahtseiles gleichförmige Bewegung möglich sein soll). C. Meissner. Mathematical. Ills. 2000 w. Schweiz Bau—Aug. 14, 1909. No. 7972 B.

Theory and Practice in Cable-Railway Construction (Beitrag zur Theorie und Praxis der Seilbahnen; die Hungerburgbahn, Tirol, und die Seilbahn auf die Tarajka, Hungary). E. E. Seefehlner. Refers specially to the Hungerburg and Tarajka cable railways. Ills. Serial. 1st part. 5500 w. Elektrotech u Maschinenbau—Aug. 1, 1909. No. 7992 D.

Construction.

National Transcontinental Railway. Duncan MacPherson. Read before the British Assn. for the Adv. of Science. Map and general description of methods pursued in locating and constructing the line. 2500 w. Can Engr—Sept. 10, 1909. No. 7688.

Construction Work on the Spokane, Portland & Seattle Ry. Illustrated description of a recently completed line of 377 miles, which shows heavy work. 1000 w. Ry & Engng Rev—Sept. 11, 1909. Serial. 1st part. No. 7614.

Curves.

The application of the Traverse Method to Railroad Curve Problems. William Clyde Willard. Gives the application of this method to the solution of several curve problems. 1000 w. Eng News—Sept. 30, 1909. No. 8205.

I. High Speed on Railway-Curves. John Wyatt Spiller. Examines the additional forces brought into action, and the best means of neutralizing their ill effects. II. A Practical Method for the Improvement of Existing Railway-Curves. William Hamilton Shortt. Explains method of introducing transition-curves. Two papers discussed together. 42000 w. Inst of Civ Engrs—Nos. 3706 and 3761. No. 8167 N.

Grade Reduction.

See Viaducts, under CIVIL ENGINEERING, BRIDGES.

Rail Joints.

Rail Joints. Alexander Ross. Report for countries using the English language. 5200 w. Ills. and Tables. Bul Int Ry Cong—Aug., 1909. No. 8026 G.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Terminals.

Duluth Passenger Terminal of the Wisconsin Central Railway. Detailed description of a terminal where the physical conditions made the construction difficult. Ills. 3500 w. Eng Rec—Sept. 25, 1909. No. 8069.

Proposed Terminal Improvements at St. Louis. Plans and description of the improvements proposed, and report of the restrictions that are the cause of controversy and delay. 2000 w. R R Age Gaz—Sept. 10, 1909. No. 7696.

Ties.

Results of Trials of Steel and Concrete Ties. Abstract of the report of the Am. Ry. Engng. & Main. of Way Assn. Gives

results of investigations made which are generally discouraging. 3000 w. Eng News—Sept. 30, 1909. No. 8210.

Track Construction.

A New Design of Railway Track Construction. Describes a system which eliminates cross-ties and relies on well-rolled bed of stone ballast to carry the load. 1000 w. Eng News—Sept. 30, 1909. No. 8209.

Strengthening the Track and the Bridges with a View to Increasing the Speed of Trains. J. W. Jacomb Hood. The report for Great Britain. 12900 w. Bul Int Ry Cong—July, 1909. No. 8021 G.

Tunnels.

Long Railway Tunnels. Construction, Ventilation and Operation. Francis Fox. On the great town tunnels in Great Britain, giving history and illustrated description. 19200 w. Bul Int Ry Cong—Aug., 1909. No. 8027 G.

Tunnel Ventilation.

The Ventilation of Tunnels (Aération des Souterrains). A general review of tunnel-ventilation methods, with reference to the Présailles tunnel of the Paris-Lyon-Mediterranean Railway. 11500 w. Ann d Ponts et Chaussées—1909-IV. No. 7909 E + F.

TRAFFIC.

Car Distribution.

Coal Car Distribution. Arthur Hale. A discussion of the difficulties in properly handling coal cars, with explanation of the present situation and the private car question. 6000 w. R R Age Gaz—Sept. 17, 1909. No. 7800.

Freight Classification.

Uniform Classification. Samuel O. Dunn. Gives a brief history of the efforts made to frame a uniform classification for freight, including the latest attempt. 2500 w. R R Age Gaz—Sept. 3, 1909. Serial. 1st part. No. 7587.

Freight Traffic.

Note on the International Convention for the Carriage of Goods on Railways, of 14 October, 1890. L. Calmar. Discussion of proposed reforms in Europe. 11000 w. Bul Int Ry Cong—Aug., 1909. No. 8029 G.

MISCELLANY.

Arabia.

The Hedschas Railway (Die mohammedanische Eisenbahn, Hedschasbahn). E. A. Ziffer. A brief general description of the line, rolling stock, etc. Ills. 4500 w. Mitt d Ver f d Förd d Lokal und Strassenbahnwesens—June, 1909. No. 7254 F.

Asia.

Railroad Building in Asia. John Foord. Interesting account of the active development now under way, and the influences which have brought the present situation. 5000 w. Ir Age—Sept. 2, 1909. No. 7515.

Earning Power.

The Earning Power of Leading Railways. F. E. Voegelin. Analyses of 22 systems, covering the years from 1899-1908. 3000 w. R R Age Gaz—Aug. 6, 1909. No. 6921.

England.

The Position of English Railways. W. M. Acworth. Reprinted from *North American Review.* Gives an outline of the present position, showing the change a half century has brought, and comparing railway conditions in, the United States and England, with discussion of state ownership and related matters. 3500 w. R R Age Gaz—Sept. 24, 1909. No. 8046.

Newburgh and North Fife Railway. Illustrated detailed description of a line 12 miles, 69 chains in length, having 43 bridges and culverts. 1500 w. Engr, Lond—July 23, 1909. No. 6859 A.

Exposition.

International Railway and Land Transport Exposition in Buenos Aires, May-Nov., 1910 (Exposicion internacional de Ferrocarriles y Transportes terrestres en Buenos Aires Mayo-Noviembre de 1910). An official prospectus, giving programme, classification of exhibits, entry charges, and regulations for the guidance of exhibitors. 7000 w. Anales d l Soc Cien Argentina—Jan., 1909. No. 7251 E + F.

Finland.

The Railways and Waterfalls of Finland. Illustrated description of the waterways, and of the improvements carried out by the State. Maps. 4500 w. Engr, Lond—Sept. 17, 1909. No. 8130 A.

Java.

The Railways of Java (Die wirtschaftlichen Eisenbahnen auf der Insel Java). E. A. Ziffer. A brief general description. Ills. 2500 w. Mitt d Ver f d Förd d Lokal u Strassenbahnwesens—July, 1909. No. 7255 F.

Mexico.

The Tehuantepec Railway and Terminal Ports. Gives the early history of this railway and a description of the line and terminal ports, with a discussion of the advantages of the route as a competitor of the Panama Railway and Canal. 2500 w. Engr, Lond—Aug. 27, 1909. Serial. 1st part. No. 7658 A.

Turkey.

Railway Development in Turkey (Les Chemins de Fer en Turquie). Louis Godard. A review of existing and projected lines. Ills. 4800 w. Génie Civil—July 3. 1909. No. 7228 D.

United States.

Railroad Building Essential to National Growth. W. J. Meany. Gives B. F. Yoakum's view of the transportation necessities of the country, giving statistics. 2500 w. Mfrs' Rec—Oct. 7, 1909. No. 8384.

We supply copies of these articles. See page 323

STREET AND ELECTRIC RAILWAYS.

Canal Haulage.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI[e] Congrès international de Navigation tenu à Saint-Petersbourg en 1908). Report of the discussion on canal traction. 8000 w. Ann d Ponts et Chaussées—1909-IV. No. 7913 E + F.

Cars.

Pay-Within Cars in Washington, D. C. Illustrates and describes the new cars being placed in service. 1500 w. Elec Ry Jour—Sept. 18, 1909. No. 7794.

Curernt Clocks.

Results with Current Recording Clocks on the Grosse Berliner Strassenbahn. A report of improvement due to the installing of clocks in place of watt-meters. 1200 w. Elec Ry Jour—Sept. 11, 1909. No. 7676.

Electric Traction.

The Development of Rapid Transit in Cities (Die Entwicklung der Stadtschnellbahnen). F. Musil. Refers particularly to conditions in Berlin and Vienna. Ills. Serial. 1st part. 2200 w. Zeitschr d Oest Ing u Arch Ver—Aug. 6, 1909. No. 7984 D.

A Criticism of August Scherl's Traction System (Kritische Betrachtungen zu einem neuen Schnellbahnsystem von August Scherl). Herr Biedermann. An examination of Scherl's proposed high-speed mono-rail system. Ills. Serial. 1st part. 2200 w. Deutsche Bau—Aug. 14, 1909. No. 7969 B.

Freight Traffic.

Freight Service of the Toledo & Western Railroad. An illustrated account of a prosperous undertaking following closely the steam railroad methods. 1200 w. Elec Ry Jour—Sept. 18, 1909. No. 7792.

Great Northern.

Electric Power Equipment for the Cascade Tunnel, Great Northern Ry. Extracts from article by A. H. Halloran, with illustrations and particulars of the three-phase installation. 1800 w. Ry & Engng Rev—Sept. 18, 1909. No. 7839.

Interurban.

Traffic Features of the Los Angeles & Redondo Railway. Illustrates and describes features of passenger and freight traffic. 1200 w. Elec Ry Jour—Sept. 11, 1909. No. 7675.

The Beebe Syndicate Interurban System in Central New York—Construction Features. Map and illustrated description of an extensive electric interurban railway system being developed to connect Syracuse, Rochester, Auburn, Oswego, and other points in Central New York. 2000 w. Elec Ry Jour—Sept. 25, 1909. No. 8036.

Locomotives.

Alternating Current Voltage Control. William B. Kouwenhover. Describes the alternating current system of control in use on the New Haven electric locomotives. 2000 w. Ry & Loc Engng—Sept., 1909. No. 7579 C.

Geared Freight Locomotive for the New York, New Haven & Hartford Railroad. Illustrated description. 1500 w. Elec Ry Jour—Sept. 25, 1909. No. 8037.

Articulated Electric Locomotive for the Detroit River Tunnel. Illustration and description of this powerful machine for hauling both passenger and freight trains through the tunnel. 2200 w. Am Engr & R R Jour—Sept., 1909. No. 7577 C.

New Electric Freight Locomotives of the Italian State Railways. (Neue elektrische Güterzuglokomotive der Italienischen Staatsbahnen). K. von Kando. Illustrated detailed description. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 7, 1909. No. 7997 D.

London.

The Tramways of the County of London. Map, and illustrated detailed description of their organization, working, construction, equipment, rolling stock, etc. 7000 w. Tram & Ry Wld—Sept. 2, 1909. No. 7765 B.

Rails.

The Origin and Development of Grooved Rails (Die Rillenschiene, ihre Entstehung und Entwicklung). Philipp Fischer. A historical review, illustrating many profiles. Serial. 1st part. 2000 w. Stahl u Eisen—Aug. 11, 1909. No. 7951 D.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Signalling.

Recent Traction Safety Devices (Neuere Zugsicherungen). L. Kohlfürst. Describes various signal systems. Ills. Serial. 1st part. 4000 w. Elek Kraft u Bahnen —Aug. 14, 1909. No. 7990 D.

Single-Phase.

Single-Phase Extensions of the Lyons (France) City Lines. Illustrates and describes the line construction and rolling stock of two 6000-volt single-phase catenary lines. 1000 w. Elec Ry Jour—Sept. 4, 1909. No. 7545.

Subways.

The Hudson and Manhattan Tunnel System. J. Vipond Davies. A detailed review of the history of the tunnel projects, the organization and work plants are given in the present number. 5000 w. R R Age Gaz—Sept. 17, 1909. Serial. 1st part. No. 7799.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.